# NATURE

No. 4432 SATURDAY, OCTOBER 9, 1954 Vol. 174


## CONTENTS


| | Page |
|---|---|
| Agricultural Research under Review | 663 |
| Science and Life. By Prof. F. J. M. Stratton, O.B.E., F.R.S. | 665 |
| The Cleavage in European Science. By F. I. G. Rawlins | 666 |
| Principles of the Measurement of Colour. By Dr. L. C. Thomson | 666 |
| Bridges. By R. H. Macmillan | 667 |
| Research on the Mammals of Africa. By Dr. L. Harrison Matthews, F.R.S. | 670 |
| Genetics and the Advancement of Science. By Dr. D. Lewis | 672 |
| Weather Forecasting | 673 |
| Obituaries : | |
| Dr. E. S. Russell, O.B.E. By Michael Graham | 675 |
| Dr. Jean White-Haney. By R. C. Traill | 676 |
| Prof. L. J. Stadler. By Prof. S. C. Harland, F.R.S. | 676 |
| News and Views | 677 |
| Social and Individual Significance of Ageing. By C. Fleming | 682 |
| Beech Mycorrhiza. By Dr. J. K. Brierley, J. S. Waid and J. M. Wilson | 684 |
| Field Biology at the King Edward VI Grammar School, Camp Hill, Birmingham | 686 |
| Comparative Performance of Nickel and Porous Alumina Sample Holders for Differential Thermal Analysis. By T. L. Webb; Dr. Robert C. Mackenzie | 686 |
| Free Radicals in Biological Materials. By Prof. Barry Commoner, Jonathan Townsend and George E. Pake | 689 |
| Letters to the Editors : | |
| Synthesis of Sucrose by a Partially Purified Plant Tissue Extract.—Dr. J. F. Turner | 692 |
| A Model System for the Olfactory Membrane.—Dr. J. T. Davies and F. H. Taylor | 693 |
| Detection of Carbohydrase in Paper Electrophoresis.—L. R. Wetter and June J. Corrigal | 695 |
| The *d-iso*Citric Lyase System : the Formation of Glyoxylic and Succinic Acids from *d-iso*Citric Acid.—Dr. J. A. Olson | 695 |
| Decomposition of Oxalate by *Streptomyces*.—S. R. Khambata and Prof. J. V. Bhat | 696 |
| Invasiveness of Sarcoma Cells.—M. Abercrombie and Dr. Joan E. M. Heaysman | 697 |
| Intracellular Distribution of Histamine.—Dr. I. Mota, W. T. Beraldo, A. G. Ferri and L. C. U. Junqueira | 698 |
| Destruction of Tumour Cells by Rift Valley Fever Virus.—Dr. N. Takemori, M. Nakano, M. Hemmi, H. Ikeda, S. Yanagida and M. Kitaoka | 699 |
| Glycogen Secretion in the Epididymis.—Dr. Lennart Nicander | 700 |
| Use of *p*-Chloromercuribenzoic Acid in the Determination of Ascorbic Acid in the Presence of Sulphydryl Compounds.—J. A. Owen, B. Iggo and D. B. Horn | 701 |
| A New Mixed Disulphide : Penicillamine–Cysteine.—Milton Tabachnick, Herman N. Eisen and Bernard Levine | 701 |
| A New Glass Cell for Preparative Counter-Current Distribution.—M. Verzele and F. Alderweireldt | 702 |
| Hydrogen Reduction of Tungsten Oxides.—M. G. Charlton | 703 |
| Quantitative Infra-Red Analysis of Mixtures.—I. R. C. McDonald | 703 |
| A New Circuit for balancing the Characteristics of Pairs of Valves.—R. E. Aitchison | 704 |
| Cytological Polymorphism in the Nematode *Hoemonchus contortus* (Rudolphi 1803) Cobb 1898.—K. C. Bremner | 704 |
| Photoperiodic Control of Germination in Seed of Birch (*Betula pubescens* Ehrh.).—M. Black and Dr. P. F. Wareing | 705 |
| Magnetic Observations at Quetta during the Total Solar Eclipse of June 30.—S. A. A. Kazmi | 706 |



*Editorial and Publishing Offices of "NATURE"*
MACMILLAN & CO., LTD
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

*Advertisements only should be addressed to*
G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number : Regent 3891



All rights reserved. Registered as a newspaper at the General Post Office


## AGRICULTURAL RESEARCH UNDER REVIEW

THAT very useful, if sometimes rather perturbing body, the Select Committee on Estimates, has in its latest report* turned its attention to agricultural research in Britain. It visited some of the research stations and examined some of the directors as well as the chief officials of the Government and other bodies concerned. Besides the verbal evidence, the report includes interesting memoranda by the Ministry of Agriculture, the Agricultural Research Council, and the Treasury; also a financial appendix showing the funds provided for the various research institutes for the sessions 1953–54 and 1954–55. The inquiry was directed to "the administration of, and expenditure on, agricultural research by the various Departments and organizations involved, but did not extend to the organizations concerned with the practical application of the results". The Committee further decided that policy and the assessment of the scientific and practical value of the work being done lay outside its terms of reference. It is highly gratifying to learn that the Committee "found no evidence of waste or inefficiency in the running of the individual institutes they examined". It did, however, find the overhead organization complex and cumbersome and suggested some simplification.

The complexity arose from historical reasons. Agricultural research in Great Britain is much older than Government interest in it. Rothamsted was founded in 1843 by a private landowner, John Bennet Lawes, and was carried on entirely at his private expense until 1889, when he transferred it to a Trust which he established and endowed and which is within the jurisdiction of the Public Trustee: it received its first Government grant in 1911. Long Ashton was started in 1893 under the ægis of the Bath and West and Southern Counties Society in the grounds of a Somerset landowner, Mr. R. Neville Grenville, for the purpose of introducing scientific methods in the making of cider; when its supporters wanted to put it on a permanent basis they were advised to form themselves into a limited liability company of a non-profit-making character under licence from the Board of Trade in conformity with the Companies' Act of 1867. The Cheshunt Experiment Station was started in 1914 by a group of glasshouse growers: they, however, were advised to register under the Friendly Societies' Act, though for the new Station at Littlehampton they are to be reconstituted under the Companies' Act. Other stations began as departments of a university; others, again, were founded by the Development Commission about 1912. From 1911 onwards these institutes received grants from the Development Fund, through the Ministry of Agriculture; but they had other resources also, usually grants from county councils and subscriptions or donations from societies or individuals interested in their work.

The receipt of a Government grant necessitated submission of the programme of work, estimates of

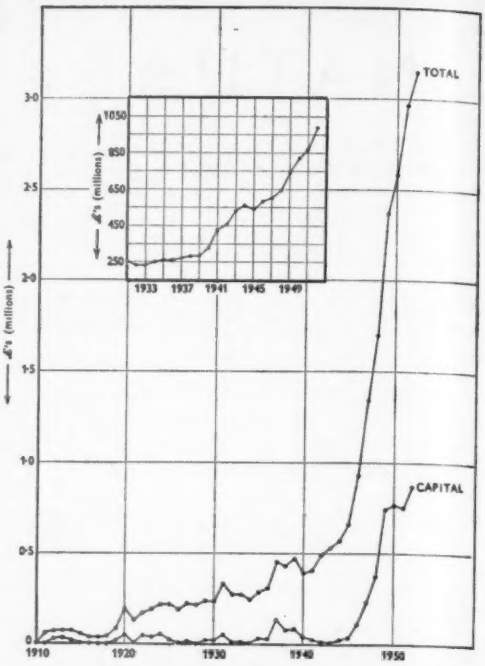
* **Fifth Report from the Select Committee on Estimates, etc. Session 1953–54. Agricultural Research. Pp. 218. (H.M.S.O.) 6s. 6d. net.**

cost, final accounts, and report on work done. Serious difficulties rarely arose so long as the Government grant formed only a moderate part of the whole income: directors and the officials concerned were on very friendly terms and could satisfactorily settle matters in advance of the formal correspondence. The system worked in the usual English fashion in spite of some illogical features. Indeed, it was so successful, and the research institutes expanded so greatly, that by 1931 it was felt necessary to set up the Agricultural Research Council to act as scientific adviser to the Development Commission and the Ministry, to advise the agricultural departments on the programmes of the research institutes, to review, co-ordinate and facilitate all agricultural work in progress and to initiate new investigations where gaps required filling, for which purpose it had funds of its own and could set up its own stations and units. The Council consists of fifteen members: not less than ten are chosen with the approval of the president of the Royal Society for their eminence in science; the others are agricultural. Directors of research institutes are not, in fact, appointed.

The steep increase in cost and the rapid increase in the amount of work has necessitated an enormous increase in the grants (see accompanying graph). Up to 1918 the total annual grants had been about £80,000 a year; by 1944 they somewhat exceeded £500,000; by 1951 they were well above £3 million; and for 1954–55 nearly £6 million. The Government grant, formerly only a fraction of the total income of the research institutes, now amounts to 98 per cent or more of the total, and the Committee considers that this justifies closer examination of the relations of the institutes to the Government. The present relations can only be described as historical accidents. Of the thirty-eight stations reviewed, two are directly controlled by the Ministry of Agriculture, fourteen are independent but come under review by the Ministry jointly with the Agricultural Research Council, and fourteen are directly under the latter body. Of the independent institutes, neither Ministry nor Council is represented on the governing body of Rothamsted, the Ministry has two representatives on that of Long Ashton, and it appoints all the governing body of the Agricultural Engineering Institute. In short, there is just that kind of administrative untidiness that a committee would enjoy straightening out—or recommending that others should do it.

In point of fact, the untidiness is not as serious as it looks. The Ministry's chief work is administration of the various Acts dealing with agriculture; but some of this work—such as plant and animal diseases, seed testing, quarantine—necessitates investigations which are much better carried out on the spot under the eye of the officer concerned than delegated to a research institute miles away. Moreover, the Agricultural Research Council has cognizance of all the research work in all the institutes, either directly or through its committees: there need be no overlapping through ignorance of what is being done elsewhere.

The Select Committee on Estimates, however, was more concerned with finance than with research. The Agricultural Research Council is described as a sister




State expenditure on agricultural research in Great Britain. Inset: annual gross value of agricultural output in Britain. From "The Agricultural Research Service", by courtesy of the Controller of H.M. Stationery Office

body to the Department of Scientific and Industrial Research, which draws its revenues largely from industrial concerns; and the question arose whether the farming industry could not contribute in like manner to the cost of the agricultural institutes. This was found to be impracticable; indeed, Government grants had dried up rather than stimulated voluntary financial efforts.

The Committee was much impressed by the fact that no one body is charged with the oversight of the total expenditure on agricultural research. The Ministry's share of expenditure comes out of the Vote, and the Council's by direct negotiation with the Treasury; but the Committee found no one whose duty it was to add up these quantities for the purpose of ascertaining the total. The Committee is strongly of opinion that overall savings could be effected if all the institutes could be brought "under one hat", either the Council or the Ministry. The institutes' representatives preferred the Council: it had more understanding of scientific work, more flexibility, and was quicker in action. At present the scientific staff is under Council regulations and the non-scientific staff under those of the Ministry; these, however, are quite unsuited to a research institute.

Some of the witnesses were rather perturbed by the fear that they might be brought more directly under the Council than hitherto they have been. So long as the Council remained a purely advisory body, the eminence of its members and their personal friendships among the staffs of the institutes gave a special value to any criticisms or suggestions they

made in regard to the work being done. But, as was pointed out to the Committee, the Council, in its recent booklet, "The Agricultural Research Service", describing its activities, now claims to 'supervise' the State-aided research institutes. The Oxford Dictionary gives as one of the meanings of this word "to superintend", and this in turn means "to have or exercise the charge or direction of". Is this what the Council is aiming at? The institutes have their own governing bodies chosen for their special knowledge of the subjects dealt with, and it would be a heavy loss if they were abolished or so weakened that no busy man would consider it worth while to serve on them. Sir William Ogg suggested that the happiest relation between the Council and the institutes would be that of the University Grants Committee to the universities, and this idea certainly seems worth following up. Alternatively, the relationship of the Medical Research Council to its institutes might be worth studying. The Committee took it for granted that the large Government grants necessarily entailed loss of independence; but claims that "the system of direct administration by the Agricultural Research Council promoted greater flexibility both of administration and of the research programmes". The Committee expressed its belief that "this could be done without interfering with the supervision at present exercised by their Governing bodies". It all turns on what exactly is meant by "direct administration". One member of the Committee suggested that there should be on the Council a non-specialist "business brain" to "judge between what is necessary and what is not". Any attempt to do this could lead only to disaster.

Public expenditure on agricultural research is now on so large a scale that full inspection of accounts must be, and indeed is, willingly accepted. The great problem is to find a system that satisfies the canons of sound finance without interfering with the freedom of action essential to the proper conduct of scientific investigation. The Committee learned that Ministers have this under consideration and therefore felt precluded from bringing it within its purview. Our present system no doubt needs tidying up; but it has, in fact, worked without waste or inefficiency as the Committee recognizes, and, we may add, it has produced a volume of work that in its relation to the available resources will bear favourable comparison with any done elsewhere.

## SCIENCE AND LIFE

### The Nature of Science and Other Lectures

By Edwin Hubble. Pp. viii+83+2 plates. (San Marino, Calif.: The Huntington Library, 1954.) 2 dollars.

WE owe to the Trustees and Friends of the Huntington Library this last testament of one of the greatest astronomers of our time. The six lectures contained in the book are divided into two groups—three on the nature and meaning of science, and three on scientists and war. Science to Edwin Hubble was the adventure in which man, equipped with his five senses, explores the universe around him. Unlike wisdom, which is peculiar to the individual, knowledge accumulates through the ages and can be passed on from one generation to the next. It piles up against some barrier, until a weak spot is found by an alert research worker, often one who is following a by-path which has stirred his curiosity. Exploration sweeps forward, guided by existing knowledge; old theories are revised, and new theories are formulated as temporary working hypotheses. New laws may be derived to be tested by further observation and experiment.

The success of the scientific method is illustrated by a quotation from George Sarton: "The saints of to-day are not necessarily more saintly than those of a thousand years ago: our artists are not necessarily greater than those of early Greece; they are likely to be inferior; and, of course, our men of science are not necessarily more intelligent than those of old; yet one thing is certain, their knowledge is at once more extensive and more accurate. The acquisition and systematization of positive knowledge is the only human activity that is truly cumulative and progressive".

A by-product of science is technology, the application of the results of science to the service of mankind. Hubble gives an account of the amazing growth of industrial research in the United States during the past thirty years. In this connexion he notes how expanding knowledge, which can be used for evil as well as good, has swept across the danger level, so that men are now in a position to wreck the civilization of the world. The last lecture in the book, "The War that must not happen", gives a grim account of what may take place if we leave our new knowledge at the disposal of traditional politics. Hubble was no pacifist. Before the days of Pearl Harbour, he was urging with all his might the duty of the United States to enter the Second World War and to pay whatever price was necessary to secure liberty for the world. It was with the utmost reluctance that, when war came, he obeyed orders to apply his scientific knowledge to problems of ballistics instead of returning to active service in the United States artillery. But he learnt at the Aberdeen Proving Ground what it meant to face the problems of active warfare unprepared: "The army would come to us with an urgent problem that had arisen in the actual fighting. I would say, 'We don't know, but of course we can find out'. 'Go ahead, find out', the army would say. 'All right. It will take so many men, so much equipment, so much time if we stop other work and give it priority'. 'Time', the army would say, 'hell, we have to cable the answer to-night'."

It is clear that Hubble would have supported wholeheartedly research work to face in advance the problems of the next war, if it should come. But he clearly saw that the modern war of technology is suicide for both sides. War must be stopped if we are to enjoy the potential blessings of new knowledge. Hubble was clear that treaty agreements are not enough. He saw one possible solution—a world authority armed with a police force for the strictly limited purpose of preserving order among the nations. It is the responsibility of all individuals to work to this end—to read up the subject, discuss it and urge the politicians to accept it. The necessity for decision and action is here and now. "We may not like the price, but it is cheap for what we buy—civilisation and life itself." F. J. M. STRATTON

# THE CLEAVAGE IN EUROPEAN SCIENCE

## Die Krisis der Europäischen Wissenschaften und die Transzendentale Phänomenologie

Eine Einleitung in die Phänomenologische Philosophie. Von Edmund Husserl. Herausgegeben von Walter Biemel. (Husserliana, Band 6.) Pp. xxii + 560. (The Hague: Martinus Nijhoff, 1954.) Paper, 23.50 guilders; cloth, 27.50 guilders.

IN this sixth volume of "Husserliana", one is faced with a fact which must be reckoned with before there is any possibility of appraising its contents, or for that matter, even of stating its purpose. This is that, in these pages, Husserl has delivered himself of an act of faith; they represent for him a creed, a system and a philosophy, united in one complex order of thought, and bound together by strong ties of urgency. He appears (as often before) in the role of an Old Testament prophet, telling the savants of Europe what has gone sadly adrift, and how yet all may come right in the end. To read this book (the German syntax of which is sometimes as exasperating as the massive prose of our own John Ruskin, and in some ways not unlike it) is to listen to a cathedral organ, sounding its deepest notes, reverberating and undergoing all manner of reflexions as their waves ascend from nave to triforium.

Thus, the judgment of science upon science itself is seen to consist in the perception of a rift between positivistic objectivism, and transcendental subjectivism. We note that, on this view, it is the cleavage itself more than the tenets involved which is at the root of the development of all subsequent European thought.

As Dr. Walter Biemel so well says in his introduction, the operative phase of the work is the subtle contrast between sections A and B of Part III, wherein phenomenology itself is the only escape from the dilemma: "via the living world or via psychology". The latter, nevertheless, needs adjustment to the appropriate *Methodik* if it is to be effective. The sense of awareness is introduced by the call to philosophy to make mankind awake to the spiritual nature of its end. There is obviously a strong teleological slant in all this, at one with Husserl's veneration for much of the Aristotelean tradition. In fact, he stresses what is well known when he asserts that the basic contribution of Greek thought to the world was its enthronement of theory, not only, so to say, placing it upon a pedestal, but firmly cementing it there. So the split begins to appear as a kind of no-man's-land wherein are likely to be found the logical presuppositions of science (*Sinnesfundament*), which have all too long remained unexamined, and which, thus occluded, have tended to deprive modern science of much of its meaningful content. In a word, why scientists do this or that is, fundamentally, more important than how they do it.

Odd as it may seem, there is a very healthy 'muscular' element at work in all this erudition, as witnessed by Husserl's spontaneous denunciation of a certain type of *intellektualistischen Snobismus*, connected clearly in his mind with the excesses of higher education. Making every allowance for the prolixity of Teutonic expression, this is always a valuable lesson, and leads on naturally to the essence of the 'cure' to which Europe should submit. In the present book, this appears in the text of a lecture given in May 1935. While science and philosophy remain 'separated', there is little chance of healing the wounds of a discordant civilization, capable—in theory—of a real degree of unity, but kept apart by an artificial competition for the perfection of techniques. When one observes that the gist of all this was expounded at Vienna nearly twenty years ago, it is only too manifest how perfectly it describes our present distresses. Not in vain maybe did Husserl once again assume the part of a seer.

Yet, to British ears something very like this was said (and majestically said) a full century ago in Dublin, and with no less an impact upon the progress of thought. Thus, John Henry, Cardinal Newman, in "The Idea of a University", argued that knowledge was a good in itself, an end for which to strive regardless of gain or loss. But he went further: he said that if, by the exclusion from the curriculum of some essential branch of learning, a gap is left unfilled, then other—and perhaps less worthy—knowledges will be 'tempted' to spill over into it, and thus ultimately to obliterate the original concept. How close this is to the rift between the two domains taken by Husserl as the primary cause of Europe's malaise. Then comes his prescription (in effect) for psychology to make haste to fill it, with philosophy keeping a watchful eye on the process; and, above all, men should not weary. Thus do transcendent minds produce (within limits) a common way for mankind to tread.

"Of possessions," says the Stagirite, "those rather are useful which bear fruit; those liberal which tend to enjoyment. By fruitful, I mean, which yield revenue; by enjoyable, where nothing accrues of consequence beyond the using."

F. I. G. Rawlins

# PRINCIPLES OF THE MEASUREMENT OF COLOUR

## The Science of Color

By the Committee on Colorimetry, Optical Society of America. Pp. xiii + 386 + 25 plates. (New York: Thomas Y. Crowell Company; London: Constable and Co., Ltd., 1953.) 63*s*. net.

THIS important work by the Committee on Colorimetry of the Optical Society of America gives an authoritative statement of the principles upon which the measurement of colour is based. The text has been compiled by a number of distinguished American writers over a period of twenty-two years and has now been thoroughly revised and brought up to date by the Committee as a whole. The precision of statement could scarcely be better, and many experienced in the measurement of colour will find a clarity of ideas often lacking in lesser works.

There is also a breadth of view which is refreshing. The first chapter provides a history of colour which begins in prehistoric times, and in further chapters the reader is led by easy stages through the anatomy, physiology, psychology and physics of colour to the technical details of colorimetry itself. No one can pretend that this vast field has been completely described in 340 pages, but the principles of the subject are well set out.

The book is one of principles issued by authority, and as such might be called "The Dogma of Colour" except that the modern meaning of this word tends to include the ideas of arrogant presentation and a

disregard for experimental facts, which are by no means in evidence here. The narrative is humbly written, and the authors have clearly been striving to eliminate partisan statements and to give well-informed references to the older workers where these are relevant. The ideas given here so clearly will enable many a worker in the field of colour to tidy up his own mind and liberate himself from loose thinking.

Chapter 1, on the history of colour, is followed in Chapter 2 by a survey of the whole field in general terms. This is illustrated by a number of colour plates built from Munsell papers. Chapter 3, on the anatomy and physiology of the eye, deals mainly with its anatomy, since much of what in the past has been called physiology is given in Chapters 4 and 5 under the heading "Psychological Concepts". Here one finds Müller's and Weber's law, dark adaptation and flicker data and an account of colour-defective vision together with many other subjects. The final Chapters 6, 7, 8 and 9 deal with the technique of colorimetry itself. Chapter 6 on the measurement of radiant energy is followed in Chapter 7 by an account of the standard luminosity data and related subjects, an explanation of the three-colour method of colorimetry and the use of the chromaticity diagram. Chapter 8 details the calculations normally undertaken in colorimetry, and the text is lavishly supplemented with tables. Few books on colour will contain so much useful numerical information. In Chapter 9 colour-measuring instruments and standards are discussed.

In such a work one looks for the very best, and it is a pity that the presentation is not uniformly good. Chapters 7, 8 and 9 are well set out and readable; but the rest of the book, aside from Chapter 1, is dull, and only someone with missionary fervour could read it through completely. Exactness of statement has often been achieved at the expense of easy and interesting reading. The presentation of Chapters 4 and 5 is particularly bad. There are only eleven line-drawings and one colour plate for 72 pages of double-column text, and this alone would bring many a reader to a halt. As a whole, the printing is good, but the colour plates are not up to the standard necessary for a book on the measurement of colour.

The biologist interested in visual mechanisms will find this book a disappointment, and the student is unlikely ever to read it completely; but for the thoughtful colorimetrist it is a statement of basic principles for which he has long been waiting.

L. C. Thomson

## BRIDGES

### The World's Great Bridges

By H. Shirley Smith. Pp. xi+180+43 plates. (London: Phoenix House, Ltd., 1953.) 15*s*. net.

WHEN a real authority on a subject can spare the time to write a book about it for the general reader, there is a chance that he will produce a masterpiece. Perhaps this book may be counted as such, for it is at once readable, informative and authoritative. The author was himself responsible for the construction, in Calcutta, of the bridge with the world's longest cantilevered span. He accordingly writes with an intimate knowledge of the problems involved in the building of a great bridge, although the word "great" in the title of the book is not so narrowly interpreted as to refer only to size; in the words of the author, it is used "in its widest sense to include bridges distinguished in their conception and design, those which advanced the science of bridge building, those in which the most formidable difficulties were overcome during construction, and last but not least the mighty spans of today".

Many popular compilations about bridges have been published; but the present book is not another rearrangement of old material. The author has, where possible, studied the original documents relating to each bridge described in detail. The first five chapters, which are concerned with the historical origins, have clearly entailed considerable research, in which the author has been assisted by Mr. Rowland J. Mainstone, who has provided twenty-four pen-and-ink illustrations, which are always clear and often distinguished. An instance of the refusal to accept current notions without verification on the site is afforded by the conjecture that the four arches still standing of the famous Pont d'Avignon are not part of the original twelfth-century structure, as was generally believed. Investigation of the original piers has revealed the presence of springings on a slightly different alignment from the present spans, which may have been reconstructed in the fourteenth century.

Continuing the chronological treatment, the author describes more recent bridge construction, by dealing successively with iron bridges, cantilevers, steel arches, reinforced concrete construction and finally with suspension bridges. The book has an adequate index and a bibliography of source material. A special chapter is devoted to "British Bridges Overseas", on which topic the author is particularly well qualified to write. The large collection of half-tone plates with which the book is embellished have been skilfully chosen to illustrate the author's discussion and are excellently reproduced.

The author himself quotes the statement that "Spain is the land of bridges. In all Europe they have few rivals, . . ." and it is disappointing, therefore, that more space has not been devoted to describing and illustrating Spanish bridges, especially as such quaint legends are attached to some of them: it is said of the bridge of St. Martin in Toledo, for example, that when the architect was finishing it he became aware of a grave error he had made, and, as he was certain that when the centre scaffolding was removed the bridge would collapse, he fell ill from anxiety. His wife, in order to conceal his mistake, set fire to the wood during the night and the bridge did indeed collapse. The architect next time made better plans and no one discovered his first error, as it was believed that the fire had been accidental. The sculptured head above the keystone of the main arch is said to be that of the architect's wife.

If a second edition of this book is required, it is hoped that the author will add a further chapter to give the reader an idea of modern trends in construction and some of the most interesting bridges which are projected. There is at present no mention of the use of new materials such as aluminium, the use of new methods of fabrication such as welding, or the potentialities of two-pin prestressed construction in steel or reinforced concrete; it would be interesting to have the author's views on all these topics and also to hear something of the work already done on such projected bridges as those across the River Severn and across the Straits of Messina.

R. H. Macmillan

## 50–100 Binomial Tables

By Harry G. Romig. (Wiley Publications in Statistics.) Pp. xxvii+172. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 32s. net.

THIS book is concerned with the tabulation of the individual terms in the binomial expansion of $(q + p)^n$ where $q = 1 - p$, and with the cumulative sums of these terms. For each value of $x(< n)$, there are a corresponding term $\binom{n}{x} q^{n-x}p^x$ and a corresponding cumulative sum formed by the addition of all the terms up to and including this particular one. Clearly, all the sequences of cumulative sums are strictly increasing to the limit unity.

The tables provide for values of $n$ lying between 50 and 100 (inclusive) in steps of 5, with $p$ ranging from 0·01 to 0·50 at 0·01 intervals. For values of $p$ between 0·51 and 0·99 we merely replace $x$ by $n - x$ and interchange $p$ and $q$. All the entries are to six decimal places, and the values of $x$ thus cease in any particular expansion when the corresponding term in that expansion is zero to this order of approximation. For example, when $n = 75$ and $p = 0{\cdot}50$, the largest significant value of $x$ is 59, and the smallest 16.

With the aid of these tables it is thus a matter of seconds to determine the probability of the occurrence of a given number of events (or of that number or less) in a sample of appropriate size. The usefulness of such a book in the field of quality control of manufactured products is thus assured, but (to quote the foreword) there will evidently be many uses for it outside this field.

The author, who was for many years engaged on quality control as a member of the technical staff of Bell Telephone Laboratories, has included a comprehensive introduction to the tables, describing their use and the methods of computation and interpolation used in their construction.

## Les Fonctions Orthogonales dans les Problèmes aux Limites de la Physique Mathématique

(Monographies du Centre National de la Recherche Scientifique.) Par Théodore Vogel. Pp. 192+4. (Paris: Éditions du Centre National de la Recherche Scientifique, 1953.) 1200 francs.

MOST engineers and physicists are familiar with the simple but powerful method of solution of the differential equations which occur in problems of wave propagation, heat transmission, etc., and which is applicable in cases where the variables are separable and where consequently the solutions are expressible in series of orthogonal functions. However, a detailed mathematical discussion of these functions is rarely included in text-books of mathematical physics, and T. Vogel's monograph should therefore prove most useful. The mathematical treatment is direct and rigorous, but only as rigorous as is required for use in problems in applied physics.

The contents consist of three chapters. The first is devoted to a study of the general properties of orthogonal functions and differential systems including perturbed systems; the second to some particular closed series, for example, the Fourier series, and other series of orthogonal polynomials and Bessel, Legendre and Mathieu functions; and the third considers several applications to particular problems, including those involving the wave equation with boundary conditions, Laplace's equation in potential theory and in the theory of elasticity, the heat equation $c\rho \dfrac{d\theta}{dt} = Q + \text{div (grad } \theta)$ in heat and hydrodynamics, and examples of calculations in which perturbation and variational methods are most suitable. S. Weintroub

## The Moon Puzzle

A Revived Classical Theory correlating the Origin of the Moon with many problems in Natural Science. By N. O. Bergquist. Pp. xiii+378. (Copenhagen: Grafisk Forlag, 1954.) n.p.

THE author of this book, who is a chemical engineer, believes that his theory forms a synthesis between the many puzzles confronting the geologist, palæontologist, geophysicist and astronomer. The main thesis of the book is that about 60 million years ago a planetoid struck the earth and lost so much energy by the collision that it fell into the sun; as a result of the impact a portion of the earth was torn off and afterwards formed the moon. The crust of the earth was given a sliding motion over the core which was tilted some degrees so that the rotational axis of the globe received a new inclination; before the collision there were no seasonal changes on the earth, "because the axis of the earth was not tilted against the ecliptic as it is now" (p. 292). So many changes are said to have occurred on the earth as a result of the collision that it is impossible to refer to all of them, but one in particular may be mentioned. Although the first flood-wave—the immediate consequence of the original impact and the quick acceleration of the earth's rotation—must have caused the death of vast numbers of saurians, the latter were not then completely exterminated. The expulsion of the material that formed the moon, followed by the creation of the Pacific and Indian Oceans and the successive flattening out of the earth, resulting from its increased rotational speed, was followed by the appearance of much dry land. This was unsuitable as breeding places for the saurians and, with other factors, was responsible for a swift end to their existence. Most of the book runs on similar lines, and in its compass of about 100,000 words little is left unexplained. It is doubtful if Mr. Bergquist's appeal to mathematicians to examine his theories will meet with any response. M. D.

## Introduction à la Lecture des Cartes Géologiques

Par Antoine Bonté. Second edition. Pp. 278. (Paris: Masson et Cie., 1953.) 1660 francs.

THE subject-matter of M. A. Bonté's book can be roughly divided into those chapters which are primarily concerned with the interpretation of geological maps and structures, and those dealing with ancillary topics—mapping methods, block diagrams, aerial photography, and descriptions of French topographic and geological maps. The book opens with a brief outline of the principles of stratigraphy and correlation, and then goes on to describe tectonic structures in general. The numerous examples are unfortunately illustrated in plan or in section only; more block diagrams would help to remind the reader that geological structures are three-dimensional. Map interpretation proper begins with simple examples of superficial deposits, horizontal beds, V-ing into valleys, etc., and continues with examples taken from the 1 : 80,000 "Carte Géologique de France". Elementary graphical constructions—three-point problems, stratum contours, completion of outcrop, etc.—are explained with carefully drawn

diagrams. Igneous intrusions are badly neglected; no mention is made of dykes, sills, ring-structures, or other minor bodies, and even batholiths are dismissed in one page containing a very simple diagram.

This book would be helpful to students who have already had some preliminary instruction in map interpretation, and seek to broaden their outlook. The general standard of the problems lies between that required for intermediate and that of a general degree. It is a useful reference book, because it contains illustrated descriptions of many French tectonic terms, index maps of the "Carte Géologique de France", and a summary of official geological maps of the countries surrounding France, together with names of agents from whom they may be obtained.

GILBERT WILSON

## Manual of the Polarizing Microscope

By Dr. A. F. Hallimond. Second edition. Pp. 204. (York: Cooke, Troughton and Simms, Ltd., 1953.) 15*s*.

THIS very useful practical handbook is written with particular reference to the series of polarizing microscopes and accessories made by its publishers; but it will be eminently useful to all who have occasion to work with any kind of polarizing microscope. The present, second edition, is greatly enlarged and virtually a new work. The approach is essentially a practical one, with little of the mathematical theory of the microscope, but with emphasis on the necessary adjustments of the apparatus, on the errors consequent on maladjustment, and on the various methods available for the measurement of those optical constants for which the polarizing microscope is particularly adapted.

After a short historical introduction and chapters on the construction of the polarizing microscope and its accessories, Dr. A. F. Hallimond discusses in detail the methods available for the measurement of optical path-differences, extinction angles, and pleochroism in transparent media. Apparatus for the examination of opaque materials by reflected polarized light is then described, and the theory of the reflexion of polarized light at normal incidence from anisotropic absorbing media is clearly outlined. This leads to the methods of measurement of the constants of absorbing media, including the reflecting power, extinction angles, rotation of the plane of polarization on reflexion, and path-difference on reflexion, and to the accurate measurement of the constants of an elliptically polarized beam of light. The universal stage is then discussed, including both orthoscopic and conoscopic techniques, and its use in determinations of refractive index. A final chapter deals with the grinding and polishing of opaque minerals, with emphasis on those aspects which differ from metallurgical practice.

M. H. HEY

## College Chemistry

A Systematic Approach. By Harry H. Sisler, Calvin A. Van der Werf and Arthur W. Davidson. Pp. x+623. (New York: The Macmillan Company, 1953.) 5.25 dollars.

AFTER a decade of teaching, the three authors combined their ideas and wrote "General Chemistry: a Systematic Approach", a text for first-year (American) university students. In this work they expounded, as well as customary introductory matter, the electronic theory of valency, the structures of solids, and other theoretical principles helpful in explaining chemical behaviour. Then, instead of leaving these ideas isolated in their several chapters, they applied them faithfully and consistently to explain the chemistry of the elements and compounds they describe. The resulting book contains the finest simple account of the selected modern theory and of its use in interpreting chemical action that the reviewer has so far met.

In response to an appeal the text of 870 pages has been abridged to make the "College Chemistry", now under review. The plan of the smaller book and the logical presentation of subject-matter are as before. The authors explain new terms such as ionization potential, ionic size, ionic radius, atomic crystals and ionic crystals, and point out the bearing of these on chemical action; they describe the Brönsted and the Lewis conceptions of an acid, discourse on the relation of acidity and basicity to electronic structure, and generally throughout the book stress the dependence of property on structure. Electronic configurations of atoms and molecules are extensively used. The subject-matter covers approximately the requirements in general and inorganic chemistry of British intermediate examinations. In addition, there is a section (47 pp.) on organic chemistry and its importance in the world of to-day. There are numerous illustrations and ample sets of questions and numerical problems. This is the kind of inorganic text for which many teachers and students have been looking.

G. FOWLES

## Chemistry of Carbon Compounds

A Modern Comprehensive Treatise. Edited by Dr. E. H. Rodd. Vol. 2, Part B: Alicyclic Compounds. Pp. xiv+489–1092. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1953.) 105*s*. net.

IT is in no way derogatory to the sections of this work already published to state that the appearance of this volume has been awaited with particular interest, including, as it does, two highly topical but somewhat complex subjects, the steroids and the triterpenes. For a worthwhile review of these two classes, the middle path of mere competence is of no use whatsoever; the task must be done superbly well or not at all. Fortunately, the editor has ensured the necessary excellence by calling on Prof. D. H. R. Barton to expound the intricacies of the triterpenes, while the steroids are in the able hands of Prof. and Mrs. C. W. Shoppee (steroid studies seem conducive towards husband and wife partnerships). From these authoritative sources one expects a great deal, and expectation is fully justified. The complicated elucidations of structure are clearly described, and stereochemical implications are kept well to the fore. Especially welcome is the admirable and timely survey of the recent remarkable synthetic feats in the steroid field.

Prof. Barton (aided by Dr. S. H. Harper) has also shouldered the burden of describing the simpler mono-, sesqui- and di-terpenes. Much of this work is solidly classical; but recent studies are also fully discussed, one of the most interesting being the elucidation, at long last, of the structure of caryophyllene and its congeners.

In a book of this scope, clear presentation of the complex formulæ involved is essential, and here one can only regard the feats of the compositor with awestruck gratitude. The flow-sheets, especially, are models of clarity and, although errors inevitably occur (for example, omission of the 11-keto group in some formulæ on p. 976), they are few and relatively trivial.

R. A. RAPHAEL

# RESEARCH ON THE MAMMALS OF AFRICA

By Dr. L. HARRISON MATTHEWS, F.R.S.
Director, Zoological Society of London

LITTLE more than a hundred years have passed since hunters such as Gordon Cumming were at their work among the vast herds of big game in the southern quarter of Africa, and little more than fifty since Selous was making a living by ivory hunting somewhat farther to the north. All those countless thousands of animals have now disappeared for ever; a few survivors are scattered over parts of the country, and some herds remain where they are preserved in the National Parks. The opening-up and white settlement of East Africa did not come until later, but although the same process of decimation began, and many parts of the country have been cleared of game, it is still possible to see great herds of wild animals that recall the accounts of conditions in South Africa given by the early travellers.

Nevertheless, the presence of enormous herds of game animals is quite incompatible with the economic exploitation of the country and the rapid expansion of the native population; the game must go, and there can be no hope of its survival outside the National Parks and game reserves. It is probable that within a century all the game of Africa will be enclosed within fences (or excluded without), and some species will have been exterminated. As yet, however, there is practically no information available on the biology of these mammals, information that is essential for successfully managing such parks and reserves. Little if anything is known of the carrying capacity per acre, in terms of game animals, of any African territory, nothing exact about the numbers of animals normally present or their fluctuations, about breeding-cycles, food preferences and requirements, or the effects of game on the environment, about the relationships of prey to predators, the incidence of parasites, and innumerable allied subjects.

Although such vast numbers of animals have been available to observation, it is surprising that so little is known about the biology of any species. A great quantity of scattered notes has been recorded about the distribution of game animals, and a small amount about their habits; but few indeed are the naturalists who have set out patiently to investigate all the details of the life-history of any one species. The information available comes mostly from sportsmen whose main interest is in killing animals, or from the casual observations of the tourist who has neither the ability nor the inclination to make a really serious study of them. Much incidental information has been collected by the numerous scientific expeditions that have gone into the field; but the main object of even their activities has been to collect dead specimens for museums rather than to study living animals. A notable exception, though it worked in Malaysia and not Africa, was the Asiatic Primate Expedition of 1937[1,2], financed by the Carnegie Institution and other American bodies, which devoted much time to studying the biology of pes as well as to collecting material for laboratory xamination and for museum exhibition at home.

Many museums throughout the world have been at pains to send out expeditions for collecting specimens "before it is too late"—yet how many complete skeletons of such a common animal as the tiger, for example, are available for study among the institutions up and down Great Britain? Now at last some zoologists are trying, also before it is too late, to make some study of the biology of the numerous interesting mammals that may not be available for study under completely wild conditions in the not so distant future. During the past twenty years a start at least has been made, and several workers have made reports upon the biology of single species that form a modest beginning to the volume of work that may be hoped for in the years to come.

Although the African elephant-shrew is a small species and cannot be classified with the game animals, the researches of the late Prof. C. J. Van der Horst[3–5] on this creature must be mentioned here, for they were among the first that offered an intensive study of any species of African mammal. They were concerned chiefly with problems of the breeding cycle, with the extraordinary phenomenon of superovulation that is very pronounced in this species, and with placentation and development. Van der Horst's untimely death was a great blow to the study of African mammals; it is much to be hoped that worthy successors will be forthcoming to fill the gap left by his loss.

In the years before the Second World War I was able, thanks to a grant-in-aid of expenses from the Royal Society, to spend some time in East Africa studying the reproduction, bionomics and systematics of the spotted hyæna[6–8]. The results were incorporated in several papers, and were privileged to be among the first to present an attempt at a comprehensive account of all the main aspects of the biology of any of the larger African mammals. The investigation of the reproductive anatomy and habits of the hyæna, which had been the subject of peculiar legends since the time of Aristotle, and probably long before, showed that the hyæna's well-known propensity for prolonged bouts of ribald laughter is, by anthropomorphic standards, not without foundation. During the course of this research it was possible to collect much information on the biology of some of the smaller mammals of Tanganyika.

Immediately after the War, Prof. P. A. Buxton was struck by the great waste of biological material inseparable from the methods of elephant control in tropical East Africa, and was the moving spirit in forming the Elephant Research Committee that was responsible for sending Dr. J. Perry to Uganda for two years, primarily to study the reproductive cycle of the African elephant in the wild. Perry's papers[9,10] on this subject, and on several other aspects of the biology of the elephant, are an important contribution to African zoology, and his incidental researches on other African mammals have provided a large amount of valuable material.

Concurrently, Dr. Lorna Kellas was working in Tanganyika on similar problems in the dik-dik, one of the lesser species of antelope that, by reason of their small size and the luxuriant cover available, are among the less conspicuous of the game animals. The results of her researches[11], now in the press, give a complete account of the breeding cycle and the placentation, and much other information on the biology of these beautiful little creatures. Dr. Kellas has recently been in Africa again, collecting biological material during a great 'kill-out' of game in a campaign against the tsetse fly in the southern Sudan, and it is confidently expected that her studies will add considerably to our knowledge of the biology of African mammals. An endeavour is being made to continue this collecting when operations are resumed next season.

Investigations into the incidence of yellow fever in East Africa and into methods for its control have necessitated considerable studies on the biology of the mammals other than man that act as reservoirs for the parasite causing the disease. The researches of A. J. Haddow[12] on the biology of the red-tailed monkey of East Africa, made in connexion with the yellow fever research, form one of the most complete investigations of any single species of African mammal, and bring together with a mass of original observations all that is known of the species, from its habits, ecology and parasites to the native legends clinging to it. Further contributions on other species are awaited from this author.

The latest similar investigation, which is still in progress, is that of Allan Brooks, who while holding a Colonial Research Fellowship has made a three years study of all aspects of the biology of the Thompson's gazelle of Tanganyika Territory. During his work he has been attached to the Tanganyika Game Department, from which he has received unlimited support and to which he has been able to render no little assistance.

It is greatly regretted that when the clearance of the country for the abortive ground-nuts scheme was undertaken no zoologist was informed of the material that might have become available for scientific examination. As a consequence, more than nine hundred black rhinoceroses were slaughtered and left to the hyænas and vultures—a timely postcard to the right quarter could have ensured that a zoologist would have been enabled to take advantage of this great destruction and have turned it to some use in elucidating many of the unanswered questions about the life-cycle of this interesting species. It is hoped that arrangements can be made to take advantage of a 'kill-out' of black rhinoceros on a much smaller scale (about fifty animals) that is shortly to be undertaken in an area of Uganda.

The desirability of making a proper scientific investigation of the mammals of Africa while there is yet time has now received official recognition, for the Game Subcommittee of the Tsetse Fly and Trypanosomiasis Committee of the Colonial Office has recommended the establishment of a team of biologists for the purpose. It was proposed that this team should work in one of the East African territories, and that it should be financed by the Governments of Tanganyika, Kenya and Uganda jointly; the arrangements were nearing completion two years ago when the promised financial support was withdrawn by one of the Governments at the last moment, and since then political disturbances have precluded a renewal of negotiations. The matter will no doubt be taken up again as soon as conditions are more favourable.

In the meantime, it is interesting to note that a fully qualified zoologist has now been added to the establishment of the Game Department of Tanganyika Territory, and one, unfortunately only temporarily, to the Veterinary Department of the Sudan; both these officers are now at work in the field. It is much to be hoped that other Governments will follow these examples and make similar appointments. The Scientific Council for Africa South of the Sahara, and the Colonial Office, are both supporting the efforts being made in various quarters to promote research on African mammals, and the Colonial Office is at present employing a zoologist to prepare a historical survey of the past and present distribution of the more important mammals. This work is being done by Miss O. J. Sidney, who has been provided with accommodation in the library of the Zoological Society of London; her researches are approaching completion and will be an invaluable background for future field workers.

The latest enterprise to promote research on the African fauna is a study-leave course primarily for officers in the Game Departments but also for those officers in other Colonial services who have the inclination and opportunities for field-work. The course is designed to give officers who have had no academic biological training some understanding of the biology of mammals and of the scientific approach to its study, and in particular to give some help in the problems that can profitably be taken up in the field by those whose tastes lie in that direction. The course consists of a fortnight's instruction at the Zoological Society of London, including demonstrations, practical work and reading; a week in the Department of Mammals at the British Museum (Natural History), where systematics and local faunas are studied; and a fortnight of instruction and demonstrations on problems of the breeding-cycle at the Royal Veterinary College. The first experimental course was held in the autumn of 1953, and at the request of the Colonial Office a second course is being provided in 1954. It is hoped that this course will become an annual event and that its usefulness will grow as experience is gained in meeting the special needs of those attending so that they may derive the utmost benefit from it.

Time is short, practically everything still remains to be done; but there is a considerable body of enthusiastic people who, if given some basic instruction and guidance, can lay the foundations for the proper investigation of the fauna of tropical lands. The information that they can collect is desirable in itself for academic science, and is essential for arriving at the correct methods of wild-life management in the National Parks and reserves where all the large species of land animals will sooner or later be segregated.

[1] *Science*, **85**, 11 (1937).
[2] Carpenter, C. R., *Comp. Psychol. Monog.*, **16**, No. 5 (1940).
[3] Horst, C. J. van der, *Trans. Roy. Soc. S. Africa*, **31**, 181 (1946).
[4] Horst, C. J. van der, *S. African J. Med. Sci.*, **7**, Biol. Supp., 55 (1942).
[5] Horst, C. J. van der, and Gillman, J., *S. African J. Med. Sci.*, **1**, Biol. Supp., 11, 87 (1946).
[6] Matthews, L. Harrison, *Phil. Trans. Roy. Soc.*, B, **230**, 1 (1939).
[7] Matthews, L. Harrison, *Proc. Zool. Soc. Lond.*, A, **109**, 43 (1939).
[8] Matthews, L. Harrison, *Proc. Zool. Soc. Lond.*, B, **109**, 237 (1939).
[9] Perry, J. S., *Phil. Trans. Roy. Soc.*, B, **237**, 93 (1953).
[10] Perry, J. S., *Proc. Zool. Soc. Lond.*, **124**, 97 (1954).
[11] Kellas, L., *Proc. Zool. Soc. Lond.* (in the press).
[12] Haddow, A. J., *Proc. Zool. Soc. Lond.*, **122**, 297 (1952).

# GENETICS AND THE ADVANCEMENT OF SCIENCE

THAT zoologists and botanists on September 6 devoted a whole day's joint session at the British Association meeting at Oxford to discuss genetics in relation to other biological sciences is perhaps evidence enough for its importance and central position. The subjects covered by the speakers, which included taxonomy and evolution, biometry and animal and plant breeding, medicine, physiology and microbiology, confirm this view. If this were not proof enough, the different methods of exposition adopted by the speakers—the historical, the broad generalization, the concrete examples illustrating one or two points, the read paper and the extempore—were in themselves a living and immediate demonstration of the great influence genetics has on human behaviour—that subtle character which is generally believed to be most tractable. This unconscious genetic experiment had its control group, for three of the speakers, all of them different in their methods, come from the same environment—the school founded by Bateson. If identical twins, trained in different schools, had been included among the speakers the experimental design would have been well-nigh perfect.

In discussing taxonomy, Prof. J. Heslop-Harrison said that almost every aspect of genetical research is relevant to taxonomy, but it would not cause a revolution in the system. Its contribution was to be found in the concept of a species as a biological unit, and that species differed generally in complex genic or structural chromosomal differences which had accumulated gradually over a long period. Genetics had revealed the nature of interspecific barriers, and a study of breeding systems as well as chromosomal analysis was essential for the proper assessment of a group: evidence for this was seen in the difficult taxonomic genera which had since been found to have an unorthodox breeding system such as apomixis. Because the full effect of genetical research had not yet been felt in taxonomy, a plea was made for reciprocal exchange of ideas and results from the two disciplines. Perhaps the speaker was unaware that geneticists are often greatly impressed with classification, because its groupings are usually confirmed by genetical studies. It would be too much to hope that genetics could give to the whole of classification the meaning and unity which atomic physics has given to the far simpler classification of the atomic table, but in some families a comparable correspondence between taxonomic differences and genetic structure can be found.

Prof. K. Mather, in his historical account of the internecine war within genetics between the Galton–Pearson group of biometricians and the Bateson school of Mendelians, traced its origin to the entirely different experimental approach adopted by the two sides to the problem of heredity. Mendel studied single sharply defined characters in carefully chosen material, the pure breeding pea, and he ignored all other variation. The confirmation of Mendel's laws by Bateson in many other plants and animals showed its wide application. Galton and Pearson, on the other hand, attempted to take into account the whole of the variation by measuring individuals, and dividing the variation into heritable and non-heritable from the correlations of these measurements for parent and offspring. The type of continuous variation found by Galton did not agree with the discontinuous variation found by Mendel. The synthesis of these was made by Sir Ronald Fisher in 1918 when he showed that a continuously variable character such as height in man could be explained on Mendelian laws by merely postulating a number of genes each with a small effect. This synthesis has been developed and is now being applied to practical breeding. But Prof. Mather pointed out that present biometrical methods such as the analysis of variance were unable to cope with the great complexities of gene interactions which occur with such polygenic systems.

Darwin was handicapped when formulating his theory of evolution by not having a basis for heredity, for he was unaware of Mendel's work. This importance of genetics for the interpretation of evolution was illustrated by Dr. E. B. Ford, who described his recent researches in the laboratory and field with butterflies. Much of Dr. Ford's earlier work had shown that the expression of a heterozygote could be altered by selection, as originally postulated by Fisher. In other words, the dominance properties of a gene could be changed. A colour pattern which in the wild was controlled by a gene with incomplete dominance—the heterozygote being intermediate between the two dominants—could be easily changed to full dominance by selection in the laboratory. That dominance was not present in the wild indicated that the heterozygotic intermediate phenotype had some selective advantage over the two homozygotes. Polymorphism for wing spotting in wild population in south-east England and the Scilly Isles had been mapped in relation to natural barriers. Small changes in vegetation in areas across an island were enough to separate populations having either a bimodal or a unimodal distribution of spots.

Turning to the practical application of genetics: Dr. A. Robertson pointed out how the early attempts in animal breeding to combine high milk yield and high fat content had failed to give the expected results on Mendelian theory, because the synthesis of biometry and mendelism had not then been made. The large number of genes concerned in these two characters, even without the complication of linkage, would require very large progenies to recover the desired combination. But the biometrical background had since been applied to practical problems with great success, particularly in the United States. A principle had emerged that with a character of high selective value there would be little genetic variation left on which to make further selection, but with a character of low selective value there would be a store of genetic variation. The application of genetic principles depended upon the type of breeding system adopted by the whole society of stock raisers. The selling of bulls from a few herds—bulls which conform to the fashionable but false standard of shape—means that all the herds of a breed are permeated with the genes from the few bull-selling herds. The use of such bulls within the existing breeding system was the cause for the failure of artificial insemination to increase milk yields. To get the full value of artificial insemination the criteria for selecting bulls must be changed.

The plant and animal breeders' problems are fundamentally similar, but differ in detail such as the number of individuals that can be raised. The large and expensive animal is a severe limitation on numbers which would never trouble a wheat breeder.

Prof. S. C. Harland described how plant selectors and hybridists without any genetical knowledge had obtained great success. But this was due to the accommodating nature of their material, and the use of genetical principles would have speeded the results. The concept of 'gene erosion' was a problem which all breeders had to face. Rigorous selection for one character was usually accompanied by a loss of 'fitness' genes. For example, the selection of large flowers in sweet peas had produced sterility under certain conditions. Such unbalanced types would not survive in the wild; but the unbalance was to a certain extent counteracted by the artificial environment of agriculture. Thus the main problem is one of genotype and environment, the study of which requires both genetics and physiology. Another important factor was mutability, for the problem of releasing variability in some material is a real handicap to the breeder. To-day, plant improvement rests largely on complex characters such as disease resistance, and hence a full knowledge of the genetics and biochemistry of physiological races is necessary.

The problems of human genetics have to be tackled differently from those in animals and plants. Prof. L. R. Penrose showed how many different morphological and physiological peculiarities are known now to be due to single genes. Some of these effects can be mitigated by treatment, others cannot. There was a fallacy in the argument advanced by some geneticists that under the cover of improved hygiene and nutrition the population is said to be deteriorating genetically. The example of the relationship between sickle-cell anæmia and resistance to malaria was evidence for this fallacy, for it showed that a gene need not necessarily be wholly good or bad. The gene for sickle-cell anæmia in a heterozygote confers complete resistance to malaria, a property which is of obvious advantage in tropical countries. In this case the hygienic control of malaria actually reduces the incidence of the sickle-cell gene. The full physiological effects of genes and the future requirements of the human race are not known, and since variety is generally advantageous it was an unsound policy to try and get rid of genes by sterilization.

The physiological effects of genes was discussed by Dr. D. Lewis, who stated that the gene, although its conception had changed from the billiard ball to a piece of chromosome of varying complexity and length, was still a working physiological unit. The effects of the gene controlling sexual incompatibility in plants was known in sufficient detail to enable us to draw a close parallel between the type of genetic control and the physiological mechanism. This relationship between genetics and physiology had a predictive value which could be applied to quite different systems; for example, to the relationship between a host plant and its fungal parasite. The cytoplasm—that other hereditary factor, less rigorous and usually subservient to the gene but a factor which plays the major part in differentiation, ageing and perhaps short-term adaptation—was now beginning not to obey rules but at least to show remarkably similar properties in organisms as diverse as the tomato, fruit fly, *Paramecium* and yeast. Since the gene was the prime cause of all physiological effect, and the cytoplasm was the means of transmitting that effect, a genetic study from the gene outwards and a physiological study inwards provided a fruitful meeting ground for collaboration.

The application of genetics to micro-organisms, particularly those which have no normal sexual cycle, was described by Dr. J. A. Roper (in a joint contribution with Dr. G. Pontecorvo). On the classical genetic theory the reassortment of genes required sexual reproduction, but in several asexual micro-organisms a 'para sexual' phenomenon occurred which made genetic analysis possible. In bacteria, transformation by a pure nucleic acid occurred; in filamentous fungi, exchange of whole chromosomes or even somatic crossing-over occurred. Micro-organisms were particularly suitable for physiological genetics where the specificity of each gene determining a single biochemical reaction had been found in great numbers.

The importance of micro-organisms was emphasized by Prof. C. D. Darlington in his summing-up. In micro-organisms development was telescoped in such a way that the gene was closer to the character, until in the virus the gene and the character were one. The almost unnoticed demonstration in 1924 of the precise segregation of characters in the four spores of a moss transferred Mendel's laws from a statistical to a direct observational basis. The taking of genetics into the field and city, that is, into real life, had begun, and a similarity of the field-work of Dr. Ford on butterflies and the sickle-cell anæmia by Allison referred to by Prof. Penrose indicated that the whole of human society could be a vast genetic experiment. But Prof. Darlington ended his talk by saying that in view of the failure of the universities and especially the social scientists to keep abreast of the advances in fundamental or genetic biology, Dr. E. D. Adrian's suggestion, in his presidential address, that mankind should be handed over for treatment to the social scientists made him "gasp".

The genes are, to use Darlington's phrase, the "long-range determiners" of not only morphological peculiarities but also of human behaviour: this is still not realized in universities and many research institutes. As for the public, it has always loathed the idea of genetic determination and has clung to the cherished and flattering old wives' tales that come within the framework of Lamarckism and not of genetics.

D. Lewis

## WEATHER FORECASTING

THE discussion on weather forecasting, arranged by Section A (Mathematics and Physics) of the British Association and held in Oxford on September 6—as might be expected after a disastrous summer with weather more than usually a matter of public concern—drew a large gathering to the Sheldonian Theatre. The chair was taken by Prof. E. H. Neville and later by Sir Harold Spencer Jones, who introduced the guest speaker from Sweden, Prof. C. G. Rossby, now director of the Meteorological Institute of the University of Stockholm but equally renowned for his work in the United States, having held chairs in both Chicago and the Massachusetts Institute of Technology.

In opening the discussion with a paper on weather forecasting as a problem in physics, Dr. R. C. Sutcliffe first remarked that weather forecasting is something more than the science on which it rests; it is a scientific profession with some hundreds of practitioners issuing some thousands of forecasts

daily for a wide variety of purposes. In a short paper it was possible only to indicate the general nature of the scientific problems; but in weather forecasting where it is impossible for every interested member of the public to be given personal advice on his own particular problem, it is particularly important that the client should have some understanding of the subject.

The problems of weather forecasting may be regarded as falling within the scope of hydrodynamics, but the methods which have been successful in other fields have so far contributed relatively little to the practical problems of weather prediction as they arise from day to day. This is because the problems are extremely complex, being concerned with non-steady and turbulent motions in the compressible fluid of a heat engine working against friction. The system is not even closed, and the composition of the fluid is continuously changing by evaporation, condensation and precipitation. Meteorology must therefore be studied as a science in its own right, and predictions about the atmosphere must depend on its observed structure and behaviour.

Dr. Sutcliffe was mainly concerned to emphasize the different scales of atmospheric systems. On any one day the circulation of the atmosphere differs widely from the long-term climatological mean, and examples from surface and upper-air weather maps of the northern hemisphere were used for showing how depressions and anticyclones frequently form over periods of one or two days. These systems are well understood scientifically and, as Prof. Rossby showed later, can be predicted by hydrodynamical theory; but they are essentially a form of large-scale turbulence and after a period of one or two days predictions become very uncertain.

Variability is present on many smaller scales—frontal systems, vertical convective systems down to variations on the scale of kilometres and metres. Much of this variability is beyond the reach of regular observations and can only be treated in statistical terms.

Weather forecasting, Dr. Sutcliffe remarked, can be regarded as based on five considerations: (1) the change in the large-scale synoptic situation; this can give for one or two days ahead the broad character of the weather and wind; (2) the effects of fronts—allowing fairly accurate timing of rain areas and major changes of wind, temperature, etc., for periods of some 12 hr. ahead; (3) the convective properties of the air masses—permitting statistical-probability statements on showers, thunderstorms, convective cloud, visibility, etc.; (4) diurnal changes—these are major considerations for temperature, humidity, convective phenomena and visibility; and (5) topographical effects—these introduce many local differences in weather.

Although formally these aspects may be considered separately, they are not independent.

Owing to the rapidity with which changes take place and to the element of dynamical instability which enters into the developments, there seems no present prospect of eliminating uncertainty from weather forecasts. Dr. Sutcliffe expressed himself as optimistic about dynamical meteorology, which has made great progress in very recent years; but he was not optimistic about persuading the atmosphere to behave in a more orderly way.

Mr. V. R. Coles spoke of the work of a practising forecaster. The forecaster depends in the first place on obtaining adequate observations, and the absence of reporting ships in some areas, for example, south of Greenland and even in the Bay of Biscay, is often a serious handicap. The stationary ocean weather ships in the Atlantic are a great boon. The erratic behaviour of depressions was illustrated by examples where extrapolation would give a good prediction and others where it failed completely. In recent years much attention has been given to upper-air conditions, and relationships between the consideration of the upper thickness or thermal patterns and the development and movement of surface depressions have been established. Mr. Coles illustrated the success of this method with an example of the rapid formation of a new anticyclone which had been very satisfactorily predicted. The methods of extrapolation, the use of tendencies and the indications from the upper air are not always consistent, and Mr. Coles thought that if much greater accuracy in forecasting is to come, it will probably be by the use of objective methods of calculation using electronic methods.

The first two speakers were mainly concerned with forecasts for some 24 hr. ahead made familiar to the public by Press and broadcasting, and it fell to Dr. J. M. Stagg to consider the possibilities of prediction for longer periods. Experience has shown, he said, that attempts to extend the forecasts to a few days ahead by the methods discussed by earlier speakers meet with little success; the accuracy falls away very quickly after the first 30–36 hr. But nevertheless, it is a commonplace observation that weather has a 'moodiness', and generally bright or dull or rainy weather may persist for long periods. Meteorologists have therefore looked for something in the atmosphere more enduring than the simple depressions and anticyclones.

Dr. Stagg referred first to certain purely empirical methods to which much attention has been given. The field of surface pressure has been elaborately analysed for periodicities and correlated with measures of geomagnetic and solar activity, and although much has been learned about the modes of oscillation of our atmosphere, little of prediction value has resulted. A phenomenon referred to as symmetry in the pressure–time curve has been discovered in Germany, in which variations of pressure have been shown to repeat in reverse order after a point in time known as a 'symmetry point'. But tests made in England were no more successful than others based on extrapolations of pressure trends; by the time a trend has become established it is already on the way to another rhythm or pattern. Methods of correlation, although they have had some success in India for monsoon prediction, generally fail in a similar way. It is not surprising that the atmospheric machine produces good relationships for a time in a particular area, as these would reflect the mode of circulation during the period; but if the mode changes, so will the correlations, and their prediction value may well be slight.

Dr. Stagg sees more of scientific interest in the dynamical-synoptic studies using mean weather charts for periods of days. In the United States, the Weather Bureau has introduced forecasts for five days, and more recently for thirty days ahead, on the basis of continuity in the evolution of mean upper-air charts over these periods. The methods have apparently had a measure of success, but are still mainly empirical, depending largely on the extrapolation of trends which may suddenly change for no known reason.

In the U.S.S.R. most attention has been given to the movements of anticyclones as the more enduring features of the synoptic patterns, and Dr. Stagg thinks it is no coincidence that long-range forecasting has been established in the great continental areas. Over the British Isles we are next door to one of the world's worst cockpits of weather disturbances, and even a slight error in predicting the mean tracks of depressions can make a forecast completely wrong for the whole country. Dr. Stagg stressed the need for physical understanding of the processes, and referred to research going on in the Meteorological Office; but he also reminded the audience of a remark made by Sir Gilbert Walker, speaking to the British Association twenty-one years ago: "Though the prestige of a meteorological service may be raised for a year or two by the issue of longer range forecasts, the harm done to the science will inevitably outweigh the good if the prophecies are found unreliable".

Prof. Rossby introduced the subject of 'numerical weather forecasting' by referring again to the broad spectrum of frequencies in atmospheric disturbances which was the theme of Dr. Sutcliffe's paper. 'Weather', in the sense of clouds and rainfall, is produced mainly by the smaller-scale disturbances which have relatively large vertical components of motion. The largest scale motions, with dimensions of some 5,000 km., are necessarily quasi-horizontal, and it is these motions which have now been shown to be amenable to direct calculation with useful accuracy. The calculations will not produce a detailed weather forecast; but they may still prove to be of much assistance to the forecaster by keeping him on the correct broad lines over periods of one or two days.

The conception of forecasting by calculation on the basis of the physical equations originated in Britain with the late L. F. Richardson some thirty years ago, but the ideas were at that time quite premature as there was no practicable way of carrying out the heavy computations. It was not until 1947 that the subject was taken up seriously at the Institute of Advanced Studies in Princeton, and since then there has been rapid progress on a research basis not only in the United States but also in Britain, where the work of Sawyer and Bushby is outstanding. In Sweden, with its present limited facilities for electronic computing, Prof. Rossby has confined attention to the simplest model of large-scale atmospheric behaviour, but he expects to be in a position to introduce more elaborate and realistic calculations in the near future. The basic idea was put very simply by Prof. Rossby. It has been shown that the vorticity (about the vertical axis) of the mean motion of the atmosphere is nearly a conservative property. It can therefore be advected with the mean motion. But by integration, with known boundary conditions, the motion itself can be calculated from the vorticity field so that, using a step-by-step method, it is possible to begin with the present known motion, determine the new field of vorticity for, say, one hour ahead by advection, compute the new field of motion by integration and so continue indefinitely until such time as accumulated errors render the calculations worthless. Mathematical refinements have improved on this simple scheme, but the principle remains the same.

Prof. Rossby remarked that "a weather forecast is a rather perishable commodity which must be marketed quickly". Only electronic methods can reduce the time of calculation to anything reasonable, as even in his present simple model there are $10^7$ operations to carry out to produce a 24-hr. prediction. But it now seems that the time spent in calculation will not be the most serious item. Much more time will be spent in making, transmitting and collecting the observations from the large area involved (some six hours) and in plotting and analysing the charts (some three hours). Attention will have to be given to these factors, and already objective analysis and diagrammatic recording are being studied.

To show once more that the computations can deal only with the broad synoptic situation and not with the details of weather, Prof. Rossby provided a diagram showing the distortion which may take place in a layer of fluid over a period of a day or two. Beginning as a chequered square of some 500 km. side, the 'fluid element' altered shape by hydrodynamical 'deformation' as though it were a handkerchief flourished in the magician's hand, with all pattern becoming confused in the folds. To analyse such motion in the practical case would require the number of observations to be increased by one or two orders of magnitude.

It was regrettable that time did not permit of general discussion after the papers, but perhaps the mistake had been in making the subject so broad. Weather forecasting is concerned to some extent with almost the whole science of meteorology, and any one of the four papers could have provided the basis for a profitable morning's symposium.

---

# OBITUARIES

## Dr. E. S. Russell, O.B.E.

In the death of E. S. Russell, on August 24, zoology lost one of its foremost thinkers. Many knew Russell as a friendly and quiet companion, who even as president of the Linnean Society of London always seemed to be as it were 'off duty'; but the formidable character underneath was revealed, for example, in the concluding passage of "Form and Function" (Murray, 1916):

"Dogmatic materialism and dogmatic theories of evolution have in the past tended to blind us to the complexity and mysteriousness of vital phenomena. We need to look at living things with new eyes and a truer sympathy. We shall then see them as active, living, passionate beings like ourselves, and we shall seek in our morphology to interpret as far as may be their form in terms of their activity.

"This is what Aristotle tried to do, and a succession of master-minds after him. We shall do well to get all the help from them we can."

Those were remarkably confident words from a man not thirty years of age. By now, thirty-eight years later, we have experienced part of the fulfilment of his demand, in the insight gained into the nature of animals by von Koehler and Bierens de Haan, by Lorenz, von Fritsch and Tinbergen; and the corresponding morphology is clearly on its way, indeed begun, by Baerends and others.

All Russell's books are exciting, alike for their scholarly marshalling of facts and for their heterodoxy. Lamarck and Samuel Butler receive honour only a little less than that accorded to his chosen

guides: Aristotle, Cuvier, von Baer and Johannes Mueller.

From 1921 to 1945 Russell was director of fishery investigations in the Ministry of Agriculture and Fisheries. As a fishery naturalist he had shown a talent for handling statistical material, conjuring biological and ecological discoveries from the records of quantities and sizes of fish on the fish-markets. Later, he decided to clarify the problem of the relation between the yield of a fishery and the vital processes that produce it: growth and reproduction, less mortality. Starting from first principles, he published, in 1931, "Some Theoretical Considerations . . .", and, as it transpired, ushered in a period of new understanding of this problem.

In the Conseil Permanent International pour l'Exploration de la Mer, Russell was an active officer; and it was there that during 1930–35 he persuaded the European governments to embark on regulation of mesh of nets and size limits for fish in the over-fished regions.

This was clearly a man of great and many-sided ability: a critic who shaped irreversibly the course of zoology and of fishery research; a sensible and humane administrator; fond of animals, naturalists and fishermen—he would always help any of them. He led a staff of scientists wisely, teaching us reliance on personality rather than in arrangements, and handing on his own sceptical appreciation that things are rarely what they seem. Would that there were more like him.

MICHAEL GRAHAM

## Dr. Jean White-Haney

THE death occurred in the United States on October 21, 1953, of Dr. Jean White-Haney, daughter of the late Mr. E. J. White, one-time assistant government astronomer in Melbourne. She was born in 1877, and after attending the Presbyterian Ladies College entered the University of Melbourne in 1901 to study biology, and graduated as B.Sc. in 1904 and M.Sc. in 1906. She was awarded a McBain Research Scholarship in the same year, and began research in the Botany Department under Prof. A. J. Ewart, at the same time taking University tutorials and teaching science at several schools, including her former one. She was also a University examiner at the public examinations. In 1908 she began full-time research under a grant from the Victorian Government. Between 1907 and 1911 thirteen papers bearing her name were published, eight papers on joint studies with Prof. Ewart and others on the flora of Australia, and also an appendix to his paper on longevity of seeds. In 1909 she was awarded a doctorate of science, being the second woman in Australia to receive this degree, for a thesis entitled "The Ferments and Latent Life of Resting Seed" which was published in the *Proceedings of the Royal Society of London*. Two papers on bitter pit in apples aroused great interest and controversy among horticulturists and staffs of State agricultural departments; the tentative view put forward by herself and Prof. Ewart, that bitter pit could be caused by arsenical spraying, was warmly debated. She was unable to complete the investigation, which was taken over by others under a joint arrangement between Federal and State Governments.

In 1912 she was appointed officer in charge of the Queensland Prickly Pear Board's research station in Dulacca, to initiate work towards eradication of this pest. In this she established the value of arsenical injections and sprays in killing the Dulacca prickly peer (*Opuntia inermis*) and of the wild cochineal insect in killing *Opuntia monacantha*, which was spreading in North Queensland and was afterwards eradicated by the insects. This work was recorded in four reports.

In 1916 she discontinued scientific work, having married Mr. Victor Haney in 1914. She continued to live in Queensland, and was member, and for a time secretary, of the Lyceum Club in Brisbane. In 1928, after further school teaching in Melbourne, she joined the staff of the Council for Scientific and Industrial Research as biological assistant and field officer. While in this position she wrote a history of Australian scientific work on the prickly pear. In 1929 she began a field investigation of the Noogoora burr (*Xanthium pungens*), which was a trouble in sheep pastures in New South Wales, and completed the basic taxonomic studies and survey of its distribution. In 1930 she joined her husband in the United States, and thereafter retired from active scientific work. Apart from one visit to Australia in 1936, she remained in that country until her death.

Dr. White-Haney is remembered by friends and former pupils for her genial personality and the enthusiasm she showed for anything she undertook, and which she succeeded in communicating to others. Several of those whose interest in biology she aroused at school, or at the university, have since made it their life's study. Even after her retirement she maintained an interest in science, and she regretted that the circumstances of her life prevented further active work, and also that she had to leave to others the completion of those investigations that she started.

R. C. TRAILL

## Prof. L. J. Stadler

THE death occurred on May 11 of Lewis J. Stadler. Born at St. Louis on July 6, 1896, he received his B.S. degree at the University of Florida in 1917, and his doctorate from the University of Missouri in 1922. After working at Harvard as a National Research Fellow in biology, he became professor of field crops at the University of Missouri. At various times he occupied the position of visiting professor at the California Institute of Technology and that of senior geneticist and later principal geneticist to the Bureau of Plant Industry of the U.S. Department of Agriculture (1930–37).

Prof. Stadler was a member of the Botanical Society of America, the Genetics Society of America (of which he was president in 1938), the American Philosophical Society and the National Academy of Sciences.

His researches were principally in the field of induced mutations in plants, and his important contribution, "The Experimental Alteration of Heredity", published as Chapter 1 in "Science in Progress", Series II, contains the gist of his findings. His work has been of great significance for plant breeding, since the induction of mutations by the use of X-rays, ultra-violet light and other agents is now a valuable technique, which has been the means of effecting valuable improvements in agricultural plants. The *American Scientist* rightly says of him: "A great scientist with a friendly spirit has departed. He will long be remembered for his devotion to scientific research and especially its application to human needs".

S. C. HARLAND

# NEWS and VIEWS

## Council for British Archæology: Scientific Research Committee

On October 1, the Executive of the Council recommended the formation of a Scientific Research Committee. This is to co-ordinate, and advise on, the applications of scientific research to archæology, to organize and screen the submission of archæological material for expert examination, and generally to act as a clearing house for information and ideas which are of mutual value to archæologists and other scientists. When the Council was formed in 1944, one of its first actions was to consider the many ways in which the natural sciences might be used to interpret and expand the results of archæological field-work. Much, for example, can be learnt of the ecological conditions in primitive settlements from a study of buried soils, peat, pollen and charcoal, while animal bones and even snail shells provide further valuable information about environment in early times. The petrological examination of stone axes, a study already begun by the Council for British Archæology, and the metallurgical analysis of implements and coins also throw light on prehistoric trade and intercourse.

These and other methods of augmenting the results of archæological discoveries were briefly outlined in "Notes for the Guidance of Archæologists in regard to Expert Evidence", published in 1947, which gave details of the facilities then available. The "Notes" are now out of date, not simply in detail, but also with respect to new scientific techniques such as the dating of archæological material by carbon-14 and fluorine content. Developments in science and technology are continually yielding new methods of potential use to archæologists who, in turn, are able to contribute to scientific research by providing accurately dated evidence for the study of metallic corrosion, cellulose degradation, and the earth's magnetic field. To promote further co-operation between scientists and archæologists, therefore, the Council had been considering the establishment of some form of permanent liaison. The proposal was first put forward earlier this year by Mr. L. Biek; and in April, a conference on "Archæology in the Laboratory" was held by the Council, at which scientists of various disciplines were invited to give their views. As a result of the conference, the Executive of the Council decided to recommend the formation of a Scientific Research Committee. Further information may be obtained from the Secretary, Council for British Archæology, 10 Bolton Gardens, London, S.W.5.

## National Technical Information Services Officers

The first meeting of National Technical Information Services Officers, organized by the European Productivity Agency of the Organization for European Economic Co-operation, was held at the Department of Scientific and Industrial Research during September 27–October 2. Representatives from the following countries attended: Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, The Netherlands, Norway, Sweden, Turkey and the United States. On September 27 Dr. A. King, chairman of the Productivity and Applied Research Committee of the European Productivity Agency and head of the Intelligence Division of the Department of Scientific and Industrial Research, welcomed the delegates. In the United Kingdom, the Department of Scientific and Industrial Research has been convinced for some time that technical information has an important part to play in the productivity drive; recently attention has been diverted from the mechanics of putting out information to the arrangements made in small and medium-sized firms to use such information. Speaking of the way in which technical information services at the national level can be run, Dr. King said that in the United Kingdom, which has a number of information services, the general policy is decentralization, leaving certain residual and co-ordinating functions to the Headquarters staff of the Department. This arrangement may not be suitable in many O.E.E.C. countries.

At one session of the meeting, 'question and answer' services in the United States, Germany and Great Britain were described, and there was general agreement that such services cannot be organized so that they pay for themselves. It was felt that O.E.E.C. could help by preparation of a paper on how question and answer centres were financed in different countries. As regards the interchange of questions and answers between national centres, it was thought that so far as possible questions should be directed to those countries in which specialized sources of information exist appropriate to the question. O.E.E.C. could facilitate this by treating as urgent the preparation of a guide to specialized technical information services in Europe. The preparation and distribution of technical digests were discussed, and in particular the problem of developing a European digest service was considered. It was thought that the best way of starting such a service would be for the European Productivity Agency to place contracts for the preparation of digests from the national literature in member countries. So far as possible these contracts would provide for the translation of the digests into one of the official languages, and would specify the type and quantity of digests required. In the meantime, the United Kingdom offered to make available copies of the United Kingdom digests at present prepared for circulation within the United Kingdom to any interested national centres. During the conference visits were made informally to the different sections of the D.S.I.R. Headquarters information services, and to the British Productivity Council, the Science Museum, the Patent Office and the Chemical Research Laboratory, Teddington.

## Human Relations in Industry

A leaflet, "Human Relations in Industry" (London: H.M.S.O., 1s. net), which is being distributed through employers' organizations, trade unions, industrial and professional organizations and other agencies in Great Britain, contains the recommendations and conclusions of a Sub-committee of the National Joint Advisory Council. The Sub-committee concluded that neither the hard facts of Britain's economic and trading position nor the differing circumstances of individual firms are sufficiently understood in industry. The remedy for this does not lie solely within an individual firm, and the Sub-committee accordingly calls for much greater clarity and consistency in government pronouncements on this subject. The Press and other organs which help to mould opinion can also do much more to help by ensuring that what they say is itself informed by a clear and consistent understanding of

our national position. The responsibility for achieving good relations is placed primarily on employers, though their efforts can be frustrated unless work-people on their side are ready to understand that any increase in their own real income depends on an increase in the prosperity of the country as a whole, and that an increase in the efficiency and prosperity of their own firms or establishments is an essential contribution to that general prosperity. Employers must therefore accept a responsibility for giving their work-people full and frank information about the fortunes of the firm. Good industrial relations are built on good faith and on mutual respect between employers' and workers' organizations, and the Sub-committee recommends that employers' organizations, nationalized industries and trade unions should increase their activities and those services which will assist in the development of such relations and that their attention should be directed to professional and other associations engaged in this field with the view of encouraging or supporting such work. The leaflet summarizes certain activities, advisory services and training courses in this field and briefly describes the work of the Committee on Human Relations in Industry which has been set up by the Department of Scientific and Industrial Research and the Medical Research Council.

## Science in New Zealand

The address delivered by H.R.H. the Duke of Edinburgh before a meeting of New Zealand scientific workers in Wellington on January 13 has been published as Bulletin No. 4 of the Royal Society of New Zealand (pp. 4. Wellington: Royal Society of New Zealand, 1954). After a tribute to the work of New Zealand men of science and to the contributions of New Zealand in scientific development, the Duke said that, although sub-division and specialization are inevitable, the interest of the individual scientific workers need not be lessened by this specialization. The day of the private adventurer in science, however, is over. Even the universities cannot meet the demands of their science faculties and are increasingly dependent on public support. Although in general the public is sympathetic and understands that this is a necessary investment, he continued, the public can only be expected to provide the funds for scientific work for national purposes such as health, agriculture, transport and defence, if it is persuaded that science for itself is a good thing, that scientific workers and their leaders are worthy and that science directly affects conditions of life and work. Those working in science have a duty to help people to understand its various branches and methods and the conditions essential for scientific work, particularly in respect of freedom of thought and investigation and communication. No country can afford to wait for the fruits of scientific research to be handed to her, and New Zealand must herself participate in the search for new knowledge. The Duke thought that the efforts of New Zealand would be best applied to problems now at hand, and that if the right conditions are created New Zealand might expect to foster centres of original scientific work of which she could be proud. In applied research, however, particularly for military purposes, he thought it would be of enormous advantage if the countries of the British Commonwealth could pool their resources. There are not enough workers in any one country of the Commonwealth to provide all the up-to-date equipment necessary to ensure that each unit is properly prepared for a possible war, and he welcomed the creation of the New Zealand Defence Science Corps.

## World Population and Resources

Prof. E. P. Stebbing, Romden Castle, Smarden, Kent, in a letter to the Editors, directs attention to what appears to be a serious omission in the PEP broadsheet with this title (see *Nature*, July 3, p. 1) and in the report of the symposium given by members of the executive of the International Geographical Union (*Nature*, June 26, p. 1218). He suggests that the conservation of water supplies is an even more pressing problem than those of finding food, materials, fuel and power for the rapidly increasing world population listed as the most urgent by PEP. In most parts of the world the maintenance of forests over catchment areas to secure an even flow of rivers and to prevent soil erosion and flooding is vital, though financially unproductive in a direct sense. Doubtless the authors of the PEP broadsheet would readily agree that water is the most vital of 'raw materials'; and the International Geographical Union has established a Commission on Arid Lands to study the problem, and its president, Prof. L. D. Stamp, has repeatedly urged that the control of water is the foundation of progress in the under-developed lands, notably Africa. The Food and Agriculture Organization has set up a Permanent European Working Party on the Conservation of Land and Water Resources and has asked all member countries to survey their areas. Unfortunately, no response has been received from the British Government, which indeed has suspended the work of the Inland Water Survey as an economy measure.

## J. A. von Segner (1704–77)

A physician who made distinguished contributions to physics and mathematics, Johann Andreas von Segner was born in Pressburg (Bratislava), Czechoslovakia, two hundred and fifty years ago, on October 9, 1704. After studying philosophy at Debrecen, where the Cartesian teachings were still followed, he graduated M.D. at the University of Jena in 1730. Attending the lectures of Georg Erhard Hamberger, professor of medicine, he acquired his lifelong interest in mathematics. In 1733 he was appointed associate professor of philosophy at Jena, and two years later professor of physics and mathematics at the newly founded University of Göttingen, where after the death of J. W. Albrecht in 1736 he was for a time the only professor in the medical faculty. In 1755 he accepted the corresponding chair at Halle. An indefatigable worker and a voluminous writer of dissertations on physics, chemistry, mathematics, geometry and medicine, he introduced a naval barometer in 1743, and in 1750 constructed a water-wheel which bears his name. While he made no original discoveries in medicine, he refuted the theories of the iatromathematical school, establishing mathematics as a handmaiden of medicine. His acquaintance with the principles of Christian Wolf led him to abandon the Cartesian philosophy. Segner's scientific merits were recognized by his contemporaries, for he was created a privy counsellor and was granted letters of nobility by the king of Prussia. He died on October 5, 1777, at the age of seventy-three.

## Steroid Reference Collection

The Clinical Endocrinology Committee of the Medical Research Council has been concerned for

some time about the supply of reference compounds for work on steroid metabolism. Difficulties have been felt particularly since the introduction of paper chromatography. A few compounds have already been made available through the National Institute for Medical Research, and arrangements are now being made to supply a wider range of steroids. The reference steroids, particularly hormone metabolites, will be provided to recognized laboratories as standards for paper chromatography, colour reactions, infra-red measurements, and mixed melting-points; also, in some cases, as standards for new methods of determination in urine and blood. The preparation of this reference collection has begun, with the help of generous gifts of steroids from industrial firms in Great Britain and overseas. The following firms have contributed materials: British Drug Houses, London; CIBA A.G., Basel; Glaxo Laboratories, Ltd., Greenford, Middlesex; Merck and Co., Inc., Rahway, N.J.; Organon N.V., Oss, Holland; Organon Laboratories, Ltd., London; Parke, Davis and Co., Detroit, Michigan; Syntex S.A., Mexico; G. D. Searle and Co., Chicago, Illinois. Further details and lists of the materials at present available can be obtained from the Medical Research Council, 38 Old Queen Street, London, S.W.1. Requests for materials not listed, and suggestions for other steroids to be added to the collection, should be submitted to Dr. W. Klyne (Postgraduate Medical School, Ducane Road, London, W.12), who is organizing the preparation of the collection. Attempts will be made to find a source or to prepare small quantities of other materials if possible. If workers have other materials which they would be willing to put into the common pool, this would enable the scheme to progress more rapidly. Offers of such materials should be sent to Dr. Klyne. A similar scheme for the provision of reference steroids is already in operation in the United States under the auspices of the United States Pharmacopoeial Convention. It is hoped that it may be possible to arrange for the exchange of samples between the two schemes.

## Solar Phenomena recorded at Kodaikanal Observatory

Bulletin Nos. 132 and 134 of the Kodaikanal Observatory embody the results of observations of prominences made at the Observatory during the year 1950. Supplementary data computed from photographs supplied by Meudon and Mt. Wilson Observatories for those days on which Kodaikanal had imperfect or no observations have been included in the bulletins. In addition to the prominences results, the results of magnetic observations made at the Observatory are included in each half-yearly Bulletin, starting with Part 2 of No. 132. The Magnetic Observatory was restarted in January 1949 as part of the post-war development programme of Kodaikanal Observatory, and this was due to the growing importance of geomagnetic observations in relation to solar phenomena and also to the proximity of Kodaikanal to the magnetic equator. Bulletin No. 133 gives the results of a statistical study of the sunspots observed at Kodaikanal during 1903–50, and compares the scheme of sunspot classification suggested by Cortie (*Astrophys. J.*, **13**; 1901; and also *Mem. Brit. Astro. Assoc.*, **23**; 1921), and Waldmeier's scheme (*Quart. Bull. Sol. Act.*, No. 77; 1947). A discussion of the relative merits of the two schemes leads to the conclusion that, in the absence of necessary arrangements for routine daily observations of the magnetic polarity of sunspots, and the necessity to adopt a scheme of visual classification which covers all the types met with in day-to-day observations (and this conforms to the usually observed life-cycle of the majority of sunspot groups and can be used unambiguously in daily work), Waldmeier's classification is more satisfactory.

## The Pacific Islander and Modern Commerce

Under the title "The Pacific Islander and Modern Commerce", the South Pacific Commission has issued as Technical Paper No. 54 (pp. 29. Noumea, New Caledonia: South Pacific Commission, 1954; 2*s*.) a report by V. D. Stace, based on field investigations in Fiji, American and Western Samoa, Papua and New Guinea, including New Britain and New Ireland, Netherlands New Guinea and New Caledonia, during July–October 1952, on the current situation and needs of the indigenous people of the region. The most urgent problem is to deal effectively with the growing desire of these people to participate more effectively in the modern world. The chief conclusions of the investigation are that while improved credit and banking facilities could promote the economic welfare of the indigenous people, at the present stage of their economic and social development, technical and administrative assistance is much more urgently needed. In promoting economic development, the main requirements are incentives, organization and practical education. Village co-operative systems, which modify and rationalize but do not discard the basic elements of the traditional communal methods of organizing production in the Pacific Islands, are more valuable than methods and facilities developed to meet the needs of environments where individualism is the rule and not the exception.

## Ethnobotany of Gilbert Islands

Prof. Katharine Luomala, anthropologist in the University of Hawaii, has written in some detail on the ethnobotany of the Gilbert Islands (*Bernice P. Bishop Museum Bull.*, **213**, pp. 1–129, Honolulu, Hawaii, 1953). This report affords a useful collation of the available but scattered information about plants of the Gilbert Islands (Micronesia), with special reference to the ethnobotanical aspect in Tabiteuea, based on the author's own observations. The paper gives a general description of the Gilbert group, in terms of location, population, geographical features, climate, domestic plants and animals, etc., and then proceeds to a survey of the sources of botanical information relating to the whole archipelago. Finally, two annotated check lists of plants of the Gilbert Islands are presented: the first groups the plants by families—a comparatively small list; the second list, which occupies some seventy pages, deals alphabetically by local name with all known plants, some of these still awaiting formal botanical identification and naming.

## Coryndon Memorial Museum: Report for 1953

The annual report of the Coryndon Memorial Museum, Nairobi, for 1953 (pp. 26+2 plates; from the Museum, Nairobi; 1954; 1*s*.), emphasizes the large amount of cultural activity which can be undertaken by an energetic curator and staff, even in a state of emergency. A fall in income from door receipts has been offset by an increase in certain grants. It is also recorded that the curator, Dr.

L. S. B. Leakey, owing to his special knowledge of the Kikuyu and their language, has devoted much time to duties connected with the Mau Mau disturbances. The year also witnessed the official opening of the new wing by which the exhibition area in the Museum is more than doubled. The extension includes some specially designed screens with paintings of botanical subjects arranged in taxonomic order; habitat groups of coral reef and freshwater and marine fish; a large-scale relief map of the East African Territories; illustrations to explain volcanic formations, rift valleys and river meanders; minerals; Miocene and Pleistocene faunas; and the Hall of Man. A large amount of routine museum work has also been carried out in spite of the extra pressure connected with the new wing.

## Growth of Wounded Etiolated *Avena* Seedlings

By using the infra-red image-converter viewing apparatus, C. L. Mer (*Ann. Bot.*, N.S., **18**, 157; 1954) has studied the effects of accurately placed localized wounds on the growth of etiolated *Avena* seedlings. It was essential to manipulate and wound the plantlings in complete darkness; the method by which this was achieved is fully described. A hypodermic needle was used for the actual wounding operation. It is shown that the brief exposure to infra-red radiation does not affect the subsequent growth of the plants in darkness. The greatest effect on mesocotyl growth occurs when the node is wounded. A superficial wound in this region reduces growth by 22 per cent; a further reduction of 10 per cent takes place when the vascular system is interrupted. The growth of the coleoptile is also reduced when the node is wounded; the greater part of the reduction is due to the interruption of the vascular bundles. Wounding the plumule also reduces the growth of the seedlings; but the data are considered to be too meagre to warrant drawing firm conclusions. The results indicate that the node is the centre controlling mesocotyl growth.

## College of Aeronautics: Awards

The award of the English Electric Research Fellowship in Aeronautics for the academic year 1954–55 has been made to Mr. M. E. Filby, of 6 Hillview Avenue, Brockworth, Gloucester. Mr. Filby is a former student of Crypt Grammar School, Gloucester, and of Lincoln College, Oxford, where he obtained an honours degree in physics. He is at present a member of the staff of the Research Department of Gloster Aircraft Co., Ltd.

The award of the Perring Scholarship for the two-year course which begins in October 1954 has been made to Mr. G. E. Smith, of 12 Grenoble Gardens, Palmers Green, London, N.13. Mr. Smith was educated at Glendale Grammar School, London, and graduated at the Imperial College of Science and Technology, where he obtained a first-class honours degree in civil engineering.

## Pan-African Congress on Prehistory

The third meeting of the Pan-African Congress on Prehistory will be held in Livingstone, Northern Rhodesia, in July 1955, the provisional dates being July 11–16. During the course of the meeting the centenary will be celebrated of the discovery of the Victoria Falls by Dr. David Livingstone and the beginning of the systematic exploration of the interior parts of the African continent north of the Zambesi. The work of the Congress is at present divided into three sections (though additional sections may be added if deemed necessary), namely: quaternary geology, general palæontology and climatology; human palæontology; and prehistoric archæology. At the meeting, symposia will be held on the Kalahari Sands, their definition, age, distribution and method of formation; the dating of the Australopithecinæ; marine strand lines, their definition, altimetric and faunal correlations; the early pebble-tool cultures, their definition, dating and distribution; and the importance and application of the carbon-14 method of dating to African prehistoric cultures. It is also proposed to hold discussions on terminology, research programmes in prehistory and allied subjects in the various African territories, the control of excavations and the care and protection of sites, and the preparation of resolutions on these subjects. A number of excursions have been arranged both to sites of prehistoric remains and to the Victoria Falls, game reserves and other places of natural beauty or general interest. The organizing secretary for the meeting at Livingstone is Dr. J. D. Clark, curator of the Rhodes-Livingstone Museum. All correspondence should be directed to the Organizing Secretary, Third Pan-African Congress on Prehistory, Rhodes–Livingstone Museum, P.O. Box 124, Livingstone, Northern Rhodesia.

## International Association of Applied Psychology

The next Congress of the International Association of Applied Psychology will be held during July 18–23, 1955, in London, plenary sessions being in the Beveridge Hall of the Senate House, University of London, and sectional meetings in Birkbeck College (which adjoins the Senate House). In addition to the opening and closing sessions, four plenary sessions will be held on the following themes: the psychologist and society; the evaluation of methods in applied psychology—the problem of criteria; the relationship between research and practice; and the assessment of attitudes and the relation of attitude to behaviour. Only invited papers, taking up about half the time, will be given at these plenary sessions, the other half being for open discussion. The rest of the Congress will be taken up by meetings at which questions relating to particular aspects of applied psychology—especially educational, clinical and occupational psychology—will be discussed. Members wishing to offer a paper should send a summary of 250 words, before December 31, to the organizing secretary, Mr. Alec Rodger, at 14 Welbeck Street, London, W.1.

## Conference on Endocrinology

A whole-day conference on "Endocrinology" has been arranged by the Joint Biology Committee and will be held at the County Hall, London, on November 13. The speakers will be Dr. A. E. Stuart Mason, of the Medical Unit, London Hospital, on "Aspects of Endocrinology: Medical Research"; Dr. H. Gardiner-Hill, senior physician at St. Thomas's Hospital, London, on "Endocrinology from the Clinical Point of View"; Dr. T. Mann, of the Molteno Institute of Biology and Parasitology, University of Cambridge, on "Aspects of Endocrinology: the Biological Approach"; and Sir Francis Knowles, senior biology master at Marlborough College, on

"Opportunities and Limitations in the Teaching of Endocrinology at the pre-University Level". The final session will be thrown open for discussion on the points raised by the speakers earlier in the day. Applications for tickets (price 6*s*.) should be made to the Secretary, Joint Biology Committee, c/o British Social Biology Council, Tavistock House South, Tavistock Square, London, W.C.1, from whom further particulars may be obtained.

## Exhibition of Kinematography in London

An exhibition of kinematography, comprising films, wall displays and apparatus, will be held by the Kinematograph Group of the Royal Photographic Society in the Society's House, 16 Princes Gate, London, S.W.7, during December 3–18. The exhibition revives an event held regularly before the outbreak of the Second World War. The films will be divided into five sections on the application of kinematography to, respectively, industry, science, medicine, education and other specialized fields. Lectures and demonstrations will also be given. Films for the exhibition may be submitted in any gauge, sound or silent, black-and-white or colour, but the running-time of any one film should not exceed forty-five minutes. It is not essential that films should be the work of one person; they can be made by groups, societies or commercial undertakings. Intending entrants should obtain an entry form as soon as possible from the Honorary Secretary, Kinematograph Group (Exhibition Committee), 16 Princes Gate, London, S.W.7, and return Part 1 of the form, duly completed, as soon as possible. The films, accompanied by Part 2 of the entry form, should be sent in by October 30.

## Radio Industry Council Awards

Since January 1, 1952, the Radio Industry Council has awarded premiums of 25 guineas each, up to an average of six a year, to writers of published articles, the object of the premiums being to encourage the publication of articles reporting technical progress and development of radio, television and electronics in Great Britain. The main points to be taken into consideration will be the value of the article in making known British achievement in radio and electronics; the originality of subject; technical interest; and presentation and clarity. Any writer will be eligible who is not paid a salary wholly or mainly for writing and not earning 25 per cent or more of his income from fees for articles or from book royalties. For articles written jointly, each author must be eligible, and the premium will be divided. Papers or periodicals which can be bought by the public on bookstalls or by subscription, at home or abroad, will be eligible, but not journals circulating exclusively to members of a trade, manufacturers' journals, or the privately published journals of professional institutions or learned societies. Entries should be made before December 31 by submitting five copies of the published article to the Secretary of the Radio Industry Council, 59 Russell Square, London, W.C.1.

## Announcements

The nineteenth Parsons Memorial Lecture will be delivered at the Institution of Mechanical Engineers by Mr. F. Dollin on October 29 at 5.30 p.m.; Mr. Dollin will speak on "Factors Influencing the Continuing Development of the Steam Turbine".

In connexion with the celebration of the jubilee of the invention of the thermionic valve by Sir Ambrose Fleming on November 16, 1904, a conversazione and exhibition will be held during November 16–18 in the Electrical Engineering Department of University College, London, and a plaque commemorating the occasion will be unveiled by the Lord President of the Council. Admission is by ticket, application for which should be made to the Assistant Secretary, University College, Gower Street, London, W.C.1.

The twenty-eighth annual general meeting of the Bedson Club will be held in the Chemical Laboratories, King's College, Newcastle upon Tyne, on October 15, after which Prof. T. S. Westoll, J. B. Simpson professor of geology in King's College, will deliver a lecture on "Fossils I have Known". Other Bedson Lectures for 1954–55 are: Prof. A. R. Ubbelohde, "Some Physicochemical Studies on π-Electron Compounds" (October 29); Dr. F. G. Mann, "The Comparative Organic Chemistry of N, P and As" (November 12); Dr. R. P. Bell, "The Place of Theoretical Chemistry in Chemical Education" (February 11); and Prof. F. J. W. Roughton, "Rapid Reactions of Hæmoglobin with $O_2$ and CO" (March 11).

British Celanese, Ltd., announces the award of research studentships in chemistry, tenable for two years from October 1 at the institutions mentioned, as follows: Mr. R. B. Pearson (University College, London), Mr. A. M. North (University of Birmingham), Mr. J. L. Tayler (Imperial College of Science and Technology, London) and R. L. Vale (University of Birmingham).

The Department of Agriculture for Scotland has awarded the following postgraduate scholarships in agricultural subjects, tenable for periods up to three years, commencing in October at the university or centre shown: *Husbandry:* I. C. Beattie, J. Frame, I. A. Munro and Miss S. M. Sweeney (University of Reading); D. C. Graham (University of California); A. M. M. McFarquhar (University of Leeds); Miss M. W. Murray (Ohio State University); W. C. Smith (Massey Agricultural College, New Zealand). The following current awards are being continued for a further period: *Husbandry:* J. Eadie (University of Edinburgh); T. D. MacLean (University of Reading); T. M. Sutherland (Iowa State College); *Agricultural Economics:* A. V. Vickery (Agricultural Economics Research Institute, Oxford); *Agricultural Engineering:* J. Roddan and J. H. S. Torrance (King's College, University of Durham).

A Conference on "Design and Application of Small Digital Computers" will be held at the Bellevue-Stratford Hotel, Philadelphia, during December 8–10. The programme includes papers on computer comparisons, input–output devices, computer systems and characteristics, mathematics, programming, and business and scientific applications. Further information can be obtained by writing to P. O. Box 7825, Philadelphia 1, Pa.

Referring to the communication entitled "Velocity of Electron Pulses" published in *Nature* of August 28, p. 398, the authors write: "We regret we omitted acknowledging the generous assistance of Imperial Chemical Industries, Ltd., which enabled one of us (D. L. R.) to carry on the work in the first year, and the maintenance grant of the Department of Scientific and Industrial Research, for the second year of these investigations".

# SOCIAL AND INDIVIDUAL SIGNIFICANCE OF AGEING

THE presence of some five hundred delegates from more than fifty countries in London during July 19–23 for the third Congress of the International Association of Gerontology must be considered an important stage in the gestation of a 'science of ageing' in Great Britain. The three main sections were: (1) Biology and Pathology; (2) Geriatric Medicine and Psychiatry; and (3) Social and Psychological. This report will be restricted to the sixty or more papers in the third section. Dr. J. H. Sheldon in his presidential address stressed the dominance of the social implications of gerontology, and said that "in many countries old age is likely to become the major social problem over the next twenty years". He emphasized the necessity for keeping a sense of proportion, "remembering that those aspects of the therapeutic art which happen to possess greatest technical interest and challenge are not necessarily those of the greatest social importance".

There was considerable appreciation in this third section—though not confined to it—that the major concern should be with the quality rather than the quantity of the later years; that fundamental and applied research should now be directed more towards social and individual adjustments to an already greatly increased expectation of life, rather than to adding still further years to life. A prime objective, as Dr. Sheldon put it, is "so to maintain the general vigour of the old that their capacity to contribute to the common effort and above all to maintain their domestic independence, is retained as long as possible".

The sessions in this third section could be grouped into three main divisions, with the first providing the background. The second such division, here considered as "The Care and Welfare of the Aged and the Ageing", related more to the negative aspects of age, those of atrophy, degeneration and decline, and was concerned with ensuring better provision of medical and social care for those requiring this as a consequence of the infirmities of ageing. These sessions were: "Residential Care", "Integration of Plans for Care in Health and Infirmity" and "Personal Services, Community Activities, Casework and Counselling". The third grouping of sessions took greater cognizance of the positive aspects of ageing, those of growth, development and maturation: "Employment Problems of Older Workers", "Employment of the Elderly" (plenary session), "Experimental Study of Skill in the Elderly" (joint session with Section 1) and "Education for Later Maturity in the U.S.". A general heading here would be "The Utilization of Later Maturity".

## Social Policy and Practice

The three main speakers in the first session, "Introduction to Problems of Social Policy", were Prof. A. Sauvy (Paris), dealing with the historical basis of gerontology, Sir Godfrey King, who provided a descriptive analysis of the operation of contemporary provisions for old age in Great Britain, and Prof. E. W. Burgess (Chicago). Prof. Sauvy outlined the three successive ways in which society has looked after its old people—a 'family phase', an 'individualist phase', and a developing 'social phase'. He considered that "the whole problem of old age must be placed on a new basis, or rather it is posed for the first time in an urgent fashion". Sir Godfrey stated that "if in general terms, we define our policy as being an intention to make old age as tolerable and pleasant as we can, many things will have to be done which will call for social decisions of the widest possible character", and that "we have only recently started to give special attention to problems of old age in this country".

Prof. Burgess discussed "The Human Aspects of Social Policy". He laid stress on a need, in planning for the well-being of older persons, for the realization that they "have essentially the same basic values and wishes as all other human beings". A social policy commensurate with the problems of ageing must take this into account—and also "the deteriorating role of older people in modern society". Older people, Prof. Burgess affirmed, have the desire common to others to engage in meaningful activities and to participate in and identify themselves with society: their need for a feeling of security is psychological as well as economic. In "meaningful activities" he included both work and recreation: "the findings of research indicate that work is not solely or even primarily a way of earning a living. It is a way of life by which people regulate and routinize their time, associate with their fellow workers, make use of their skills, gain recognition, achieve status, nurture a feeling of usefulness and find expression in creative activity and in the service of others".

The "Symposium on National Programmes" was not very informative, and it would appear that, strictly speaking, such programmes on age and ageing are not yet in evidence.

Mr. Clark Tibbitts, the chairman of the plenary session, "Critique of Surveys", specified the three areas of inquiry as: general conditions and adjustment of the elderly, their health status, and various aspects of employment of older people. The three papers provided illustrations of these. Dr. M. L. Barron (Cornell) described a nation-wide longitudinal investigation initiated in 1952 to study the effects of occupational retirement and the relationship between health, economic, psychological and social factors in old age; Dr. J. V. Zonnefield reported a medico-social survey of the aged in the Netherlands; and Mr. L. Moss commented on the data from the 1950 Ministry of Labour sample survey on the employment of the elderly. The chairman had pointed out that the primary concern for that session was in survey methods: "are the methods in use satisfactory for getting the kind of information wanted?"

Mr. Moss stated that the main purpose of the Social Survey inquiry was to get "an all-round appraisal of the problem". He gave an account of the rationale of the cross-sectional representative sample survey, showing its relation to detailed inquiries concentrating on one special aspect of a problem. Dr. Barron pointed out that longitudinal studies of the ageing process are better equipped to show relationships between certain factors than are cross-sectional surveys. In his address opening the discussion, Mr. Mark Abrams expressed doubts

whether the survey methods in use in Great Britain are fully satisfactory: "we are in danger of merely multiplying our stock of familiar facts". He advocated a considerable widening of the age-span normally considered in old-age surveys, the use here of longitudinal studies of ageing, and also the necessity for a multi-discipline approach: "Hitherto statisticians and medical men have tended to have a monopoly of the planning, direction and interpretation of surveys; research would be more illuminating if their tasks were shared with experts from other fields—sociology, economics, architecture, government and even history".

## Care and Welfare of the Aged and the Ageing

There was general agreement among the speakers on the need to prevent any undue increase in the institutional care of the aged. Apart from the shortage of existing hospital and similar accommodation and the mounting social burden involved, Dr. G. Evans, among others, emphasized that it is in the interests of older people that "residential care should be exceptional rather than normal"; main emphasis should be put on preventive work and rehabilitation. But though infirmity was not accepted as a dominant or necessary characteristic of later years, it was recognized that a greater incidence of this must be expected in the final years of life, and also that the increased numbers and proportion of the aged have already made heavy demands on available medical and nursing facilities. Dr. R. C. Walsh spoke of an inadequate response to the problem of the elderly sick and infirm as an "overshadowing challenge" calling for "an imaginative response from health and welfare organizations".

In his paper, "Making the Best of Available Accommodation", Dr. G. W. H. Townsend advocated that hospital beds should "be occupied by the right people and for as short a time as possible" and that "if we are to decrease the demand for beds, every precaution must be taken to see that the aged persons remain self-sufficient or at any rate members of their own family as long as possible". He stressed the value of day hospitals such as that pioneered by Dr. Cosin in Oxford. Dr. Nain Cowen spoke later of the Rutherglen Health Centre for Old People, the chief purpose of which is to keep older people active and healthy at home.

From the chair, Mrs. M. M. C. Kemball had directed attention to a required partnership embracing the family, the voluntary bodies and the statutory services for ensuring the health, care and attention of older people. Various delegates spoke of the importance of enabling the family to make its vital contribution to this partnership and gave accounts of ancillary services and aids provided by voluntary and statutory bodies for this purpose, and to help preserve the independence of the elderly.

Many speakers discussed what is in effect another type of welfare as most appropriate to those not functionally old, that being to allow, encourage and enable them to live substantially normal lives for as long as possible with continued exercise of their capacities and for a fuller development of their personalities over the penultimate period of life. Mr. L. Kuplan's paper, "The Community and the Senior Citizen", was a declaration of the principles basic to this approach, as well as a report of what he described as "an exciting demonstration of democracy in action". He said that, following a State-wide conference on the problems of ageing held in 1951, "the State of California and many of its cities and towns have accepted the principle that the older person must be encouraged and helped to remain an integral and contributory member of the community. Accepted also the corollary principle that the older person must be permitted to live through the later years in self-respect, dignity, security and usefulness". Dr. C. O. S. Blyth Brook, for one, spoke of the sense of service to others as well as the physical and mental exercise involved in suitable employment, as factors checking the conversion of senescence into senility. Dr. J. Weil (Ohio) said "the older person content only with leisure must lose his self-esteem—of purpose for living". The place and purpose of recreation for the well-being of the elderly was discussed by Miss G. E. Bowen (Philadelphia) and Miss V. Ingram (New York). They interpreted its true role as re-creation, so as "to bring the older persons back into the stream of life and help them maintain a maximum of mental health and usefulness" in "an active, creative routine instead of a dull, monotonous one".

## Utilization of Later Maturity

"The goals of gerontology must not be viewed as revolving around putting oldsters to work, but to assure that older workers who need work, want work, and who can be fitted for work are given equal opportunities with others to obtain work." In saying this, Mr. A. J. Abrams (New York) had in mind "culture-borne negative attitudes to ageing" as an infringement of democratic, equalitarian concepts. He reported discrimination against older workers as universal, and even evident well before the sixties. He spoke also of initial steps being taken to offset this through job analysis, physical examinations, job counselling, re-training and "re-engineering of jobs to adapt them to ageing workers". An international pooling of data was advocated. But Mr. Abrams felt that, though more technical knowledge is required, there are "enough data already available—so that any country, determined to aid its older workers, need not flounder". Mr. J. A. Scott, in his "Placement of Older Workers", described successful Canadian experiments in older-age counselling. Dr. I. M. Richardson suggested that encouragement and enablement of older workers to go on working efficiently longer than at present is the central problem which would help to solve other problems of old age; but that true preventive measures must be made from the fifties or even earlier.

In his earlier commentary on the 1950 Social Survey, which showed that 23 per cent of the men had retired before sixty, average retiring age being sixty-two, Mr. Moss mentioned that the investigation had also shown no marked difference in the age at which men gave up jobs in different industries and occupations. An implication of this was, he felt, that it was not the actual demands of the job which determined time of retirement but rather attitudes—on the part of the workers themselves and of management. Mr. A. J. Abrams considered that though "oldsters themselves tend to accept the community's image of the older worker", there is a changing of attitudes from retirement, even early retirement, as a life goal. One finding of the British survey was that, at sixty-five years of age and older, much larger numbers of people had stated that they went on working because they preferred to be occupied, irrespective of economic necessity. In a later paper,

Mr. J. Roberts dealt with factors in the trade union attitude to this question. He indicated that the principle of "the right to work" is now tentatively being extended to "the right to work for all adults irrespective of age".

Several papers touched on attitudes of employers to the employability of older workers. Mr. Moss felt that in spite of "a limited amount of goodwill" on the retention and taking on of such workers, "the prospects do not appear to be very favourable as long as present attitudes are dominant". Mr. A. J. Abrams mentioned the ineffectiveness of 'exhortation' or even 'proof' for removing age barriers in industry, and the necessity "to motivate top-management to examine personally this problem". "A Report on the Effectiveness of 3,000 Older Workers in a Sampling of American Business Firms" was given by Mr. R. L. Peterson. In this inquiry older workers were evaluated by their immediate supervisors, who used as a comparison "their concept of the average younger worker". The report findings, on those more than sixty years of age, showed "a work volume about the same as for younger workers", as well as less absenteeism, greater reliability and work of better quality. He stated that studies of this kind are influencing American employers to modify their employment programmes.

Mr. A. T. Welford outlined "a minimum programme of research" of an experimental psychological nature on capacities and job demands, which he felt would need to be completed "before a confident policy for employment of older people could be framed". But he pointed out that there are other questions demanding "a method of study which so far has been little used for work on ageing". Examples of these given by Mr. Welford were, "the direct measurement of performance at work on the shop floor and . . . experiments in modifying work to older people". In the joint session, "Experimental Study of Skill in the Elderly", Dr. H. E. Jones (California) observed that "the study of age changes in human abilities has a scientific history of hardly more than twenty years"; Mr. W. T. Singleton pointed out, moreover, that "research in the field of gerontology would appear to have been more concerned with somatic changes than with psychological ones". There were a number of references to the decline of certain mental abilities from a quite early age; but Mme. S. Pacaud (Paris), referring to her experimental studies, emphasized the importance of education as a check on the destructive effects of ageing, and Dr. D. Wechsler (New York) discussed the problems of appraising intelligence in older people; he questioned "whether identical tests identically performed measure the same thing" in this connexion; he also suggested that sagacity or wisdom is an added aspect of intelligence at later years.

Although the papers in the session "Education for Later Maturity" were all contributed by American speakers, a number of other delegates in various sessions stressed the importance of this factor. Three aspects of such education were considered: for personnel concerned with the care of the aged, for the ageing person himself, and for the community in general. Mr. A. J. Carlson discussed the value of adult education in "preparation for the senior years". Mr. O. J. Kaplan, in "Communication of Health Knowledge to Older Persons by Radio and Television", observed that "advances in gerontology have little meaning unless they are reflected in the life and habits of older persons . . . though there was much knowledge already it was misunderstood and unknown by many over 60". Two papers on projects for later-age education were given by Dr. Ruth Andrus and Dr. Wilma Donahue, and Dr. W. H. Reals, speaking on "Programmes for the Ageing in American Universities", reported their rapid development during the past six or seven years. From his surveys, Dr. Reals concluded, "there appears convincing evidence that the problems of ageing and educational provision for the older adult himself have become a definite and increasing concern of universities in the United States".

What would amount to a fourth aspect of 'education' on ageing was indicated by Dr. E. Digby, who questioned "whether there is sufficient thinking together of the biological, psychological and social sides". Miss E. I. Black also, as chairman of this third section, felt that it had a lot to learn from the discussion in the other sections—"but that the traffic should not be one way". This consideration, however, presupposes some evenness in the contribution of research data from the different fields of gerontological inquiry. Though ageing has now become "a major socio-medical problem", it is perhaps significant that there were very few papers of an essentially sociological character in this third section originally specified as "Sociology and Psychology". Dr. Sheldon's comment on "a lack of fundamental thinking in our approach to old age" appears to have a bearing here. In his address, however, Sir Godfrey King had remarked that, with other communities in similar demographic circumstances, "we are now going through a process of adjusting ourselves to the facts". There was an agreement among speakers that research findings from different fields of investigation would need to be taken into account by other specialists if the required unified though multi-aspect science of gerontology is actually to be constituted for the welfare of society.

C. Fleming

## BEECH MYCORRHIZA

At the British Association meeting in Oxford on September 3, three papers were read before Section K (Botany) under the chairmanship of Dr. J. L. Harley on the subject of ectotrophic beech mycorrhizas. A great deal of progress has been made in recent years on this subject at Oxford by Dr. Harley and his collaborators: the speakers were pupils of his.

The first speaker, Dr. J. K. Brierley, showed that beech mycorrhizas consisted of a fungal sheath 25–40 μ thick which surrounded a core of host tissue. An account of experiments was given which helped to determine a route by which phosphorus passed through the fungal sheath to the host. He showed that when roots which had been exposed to labelled phosphate were transferred to *phosphate-free* aerated buffer solution, part of the phosphorus accumulated by the fungus during exposure to phosphate is redistributed to the host during the subsequent stage in phosphate-free buffer. Although previous experiments have shown that movement of phosphorus to the host takes place during absorption from an external supply, the experiments described here showed that movement could take place from previously accumulated phosphorus in the fungal tissues to the host in the absence of an external phosphorus supply. Redistribution, as this movement was

called, was temperature-sensitive and had a $Q_{10}$ of 2 or greater; it was sensitive to oxygen concentration and became very slow in rate when the oxygen concentration in the washing solution was below 3 per cent.

The observations therefore demonstrated that redistribution was a movement which depended upon metabolic processes and was thus an active transport. It seemed probable that active transport of phosphorus from fungus to host was dependent upon oxidative reactions which occurred in the fungal tissue and perhaps in a lesser degree only upon those of the host. Correlating these laboratory experiments with those made in the field, Dr. Brierley showed that the oxygen concentrations of beech litter, in which mycorrhizas are abundant, were high (about 20 per cent) throughout the year. Hence, under these conditions the rate of active transport to the host would not be impeded and the mechanism was potentially capable of maintaining a steady movement of phosphorus to the host from that accumulated in the fungus.

Dr. Brierley went on to describe experiments which showed that redistribution was diminished in rate when roots were washed in buffer containing phosphate. When roots which had been returned to phosphate-free buffer after a period in buffer containing phosphate, redistribution, temporarily prevented, was resumed at a rapid rate. It was suggested that the phosphate absorbed from the external solution competed successfully with the redistribution mechanism for a substance which, produced in respiratory metabolism, was important for phosphorus transport to the host, so that phosphorus accumulated by the fungus was not mobilized for redistribution. In the absence of external phosphate supply, phosphorus already accumulated into the fungus was utilized and redistribution occurred. Movement of phosphorus into the core was mainly from the external solution when this contained phosphate; but was from sheath phosphorus via the redistribution mechanism when the external supply was stopped. Under natural conditions, fluctuations in available phosphorus must occur, and where supplies of phosphorus were abundant redistribution might be unimportant as a source of phosphorus to the host; but when these supplies failed or became very low, redistribution to the host from phosphorus previously accumulated into the fungus might be of great importance.

In order to further understanding of the role of mineral nutrition in the ecology of beech mycorrhizas, experiments are in progress at Oxford on the uptake of another of the major nutrients, the cation potassium, in contradistinction to the phosphate anion. Mr. Wilson presented the results of some of these essentially preliminary experiments with potassium. Factors affecting the uptake of potassium have been studied by two methods: (1) using an EEL flame photometer measuring differences in $K^+$ concentration of a solution before and after presentation to the roots; (2) using $Rb^{86}$ and an end-window Geiger counter. The uptakes of $Rb^+$ and $K^+$ have been shown to be similar under various conditions, when calculated on a millimolar/milli-equivalent basis.

Uptake of these alkali metals is at least partially metabolic, for sodium azide, iodoacetate, low temperatures ($Q_{10}$ of uptake more than 2), and low oxygen tensions all reduce the uptake of $Rb^+$, and the last factor considerably reduces the rubidium percentage retained in the fungus. Not only do sodium azide and oxygen tensions less than 5 per cent reduce the uptake of $Rb^+$ from rubidium chloride, but they also cause a great release of $K^+$ into both demineralized water and into dilute potassium chloride. Stronger solutions of potassium chloride, however, reduce the net loss of $K^+$ in the absence of oxygen but increase the loss of $Rb^+$ in air from roots previously charged with $Rb^+$; further, the loss of $Rb^+$ into demineralized water has a much lower $Q_{10}$ than has uptake. These facts indicate that the loss of $K^+$ and $Rb^+$ is at least partially a physical process. The $Rb^+$ accumulation ratio in rubidium chloride of nearly six times in the total absence of oxygen is partially by exchange, for approximately seven times as many milli-equivalents of $K^+$ are lost as are $Rb^+$ taken up under similar conditions. This loss of $K^+$ represents but 20 per cent of the original root content of about 3,000 μgm. potassium/100 mgm. dry weight of roots, of which approximately 45 per cent is in the sheath.

Buffering with sodium phthalate/sodium hydroxide showed that the $Na^+$ ion depressed $Rb^+$ uptake. Further experiments demonstrated that $Na^+$, $K^+$ and $NH_4^+$ caused depressions in the $Rb^+$ uptake of 10, 65 and 32 per cent, respectively, when equimolar with the 0·1 millimolar rubidium chloride solution, and that a depression of 50 per cent was produced by potassium chloride at 0·08 m*M* and by ammonium chloride at 1·8 m*M*, while sodium chloride appeared to be above 10·0 m*M*. Curves of uptake/concentration for the single salts sodium chloride and potassium chloride at the points of equal uptake in μ equivalents

provided the ratio $\frac{[Na^+]}{[K^+]}$ in millimoles/litre = 1·3,

which is far removed from their relative values as competitors with $Rb^+$. Further experiments are scheduled to determine the rates of uptake of $K^+$, $Na^+$, $NH_4^+$ in the presence of $Rb^+$ and of each other, and it is hoped these will clarify the nature of this problem.

Mr. J. S. Waid (now at the Grassland Research Station, Hurley) described the fungi which inhabit the surfaces of beech roots. He outlined a method of sampling fungi inhabiting the surfaces of uninfected roots and ectotrophic mycorrhizas: the method also demonstrated the pattern of colonization of roots by fungi, and confirms some visual observations. Roots were washed in sterile water contained in phials which were mechanically agitated. The water was changed at intervals and after twenty changes the roots were cut into 2-mm. fragments and implanted on nutrient agar plates. Dilution plates were made to determine the number of micro-organisms in the washings and showed that large numbers of sporing fungi characteristic of the 'rhizosphere' were removed from the root region in initial washings and very few in later washings. Microscopical examination showed that propagules were absent upon the surfaces of washed roots, and this evidence, together with that derived from sampling the washings, indicated that only the active mycelia of the root surfaces remained upon the washed fragments.

Examination of the roots of single seedlings showed that different types of fungal infection, including mycorrhizal, could occur on adjacent lateral systems. The population appearing from washed samples of laterals from the same host plant also showed great variation, but the majority of fungi on secondary laterals were non-sporing and a flora of clamp-bearing and sterile mycelia grew from mycorrhizas.

The tap roots bore a less variable but denser population, mainly of sporing fungi, but of different quality from the fungi appearing on Warcup soil plates made with soil from pots in which the plants had grown. Fungi were often absent on growing apices; but as the roots aged the population of fungi appearing on plates increased in numbers and was dominated by sporing fungi.

In another experiment seedlings were grown in beechwood soil but in light intensities ranging from 25·1 to 3·6 per cent daylight. Shading not only resulted in a decrease in the dry weight, free sugar content and the extent of mycorrhizal infection of the seedlings but led also to profound changes in the nature of the surface populations of main and lateral roots. However, these effects cannot be attributed to light alone but to other factors also, such as humidity and temperature.

The numbers of *Rhizoctonia* spp. and *Trichoderma viride* were favoured by decreasing and increasing radiation respectively. *Rhizoctonia*, which is pathogenic to seedlings, was antagonized on the sampling plates by *Trichoderma*, and as the season advanced and mycorrhizas developed, the numbers of the antagonist increased, while those of the pathogen decreased. There was evidence, however, that *Trichoderma* did not entirely determine the numbers of *Rhizoctonia* on the roots. It was indicated that the condition of the host plant plays a major part in determining the nature of its surface flora and that the observations were limited by the fact that a cultural technique was employed which favoured *Trichoderma*.

J. K. Brierley
J. S. Waid
J. M. Wilson

## FIELD BIOLOGY AT THE KING EDWARD VI GRAMMAR SCHOOL, CAMP HILL, BIRMINGHAM

KING Edward VI Grammar School, Camp Hill, Birmingham, has recently published a full report by its Natural History Society of a comprehensive survey of a selected area named for convenience Brown's Coppice, the actual name of the principal woodland on the site ("Brown's Coppice: a Survey". Pp. 79. Obtainable from The Secretary, The Natural History Society, King Edward VI Grammar School for Boys, Camp Hill, Birmingham. 5*s*. including postage). The site is about 130 acres in extent, and comprises eight distinct habitats. Forty members of the Society took part in the survey. The studies were divided into nine sections—botany, zoology, ornithology, entomology, edaphic factor, cartography, specialized photography, geography and local history; and a member was appointed to supervise the work of each section. (Later a pond section, devoted to the study of a flooded bomb crater, was added.)

The report is divided into three parts. Part 1 (Physical Features) deals with geography—general and regional setting, relief, drainage and climate; and land utilization—local history and agriculture. This report is commendably thorough, the first chapter being accompanied by six maps and figures and the second by two maps.

Part 2 (Dependent Factors) reports ecological studies—index of habitats, edaphic factor, biotic factor (plant and animal). The habitats included woodland (40 acres), bog (20 acres), pasture (20 acres), hedgerows, standing water (1 acre) and waste land (about 4 acres). This is accompanied by ten maps, transects and quadrats.

Part 3 (Natural History) covers the main groups of the flora and fauna. Twelve pages are needed to list the plants identified, and these are accompanied by six plates. The various fungi, too, are listed. Some good work in bacteriology is also reported, and this is of particular interest since the subject usually receives such scant treatment in schools. Similar detailed treatment is afforded to the fauna, including invertebrates and mammals; separate chapters are devoted to insects and birds. Further plates illustrate a giant puffball, two birds, a photomicrograph of a blow-fly and one of *Cyclops*.

Three appendixes complete this report, which is the most comprehensive and thorough of its kind which we have seen produced by a school. King Edward VI Grammar School, Camp Hill, Birmingham, is to be congratulated on a very worthy effort.

## COMPARATIVE PERFORMANCE OF NICKEL AND POROUS ALUMINA SAMPLE HOLDERS FOR DIFFERENTIAL THERMAL ANALYSIS

DURING a comparative evaluation of the performance, under identical conditions, of porous sintered alumina and nickel specimen holders for use in differential thermal analysis, it was observed that for certain reactions involving the evolution of a gas, such as the thermal decomposition of a calcium hydroxide ($Ca(OH)_2$) and calcium carbonate ($CaCO_3$) and mixtures of these two compounds, the significant linear portion of the downsweep of the peak occurred at appreciably higher temperatures when using a nickel block than when using an alumina block of identical dimensions. The cylindrical sample holders used were 41 mm. high and 38 mm. in diameter, with sample wells 13 mm. wide and 19 mm. deep. A linear heating rate of 15° C. per min. was employed.

The curves obtained using the two types of sample holder are superimposed to facilitate interpretation (Fig. 1). The peak displacement observed is illustrated in curve 1 for a calcium hydroxide–calcium carbonate mixture, and in curve 2 for pure calcium carbonate.

This anomaly could not be accounted for by considerations of thermal conductivity or heat capacity, and it was also found that the peaks due to phase-changes such as the α–β quartz transformation[1] and the rhombic–trigonal inversion in strontium carbonate[2] showed no such displacement. This suggested that loss of gas in the decomposition of calcium hydroxide and carbonate might be responsible for the anomaly, in that the pores in the alumina sample holder permitted the escape of the gaseous decomposition products, lowering the concentration of the gas in the mass of sample, and so leading to the more rapid completion of the reaction. Following the reasoning that if the porous alumina block could be rendered impermeable to gas this effect would be eliminated, thin impervious linings of vitreous silica were fitted to the sample wells in the alumina block. In this modified block, the anomaly disappeared, as shown in curves 3 and 4, respectively, for calcium hydroxide and calcium carbonate. Bearing in mind

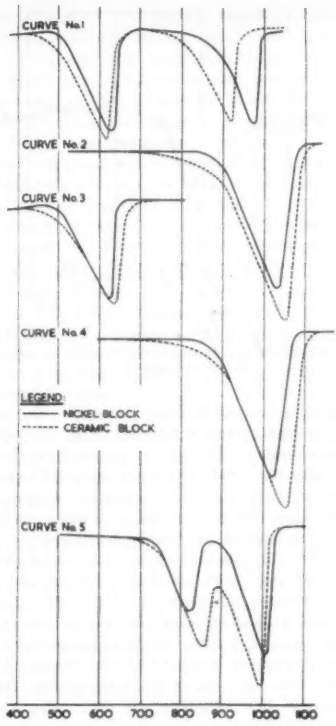



Fig. 1

that in a static atmosphere the thermal decomposition of magnesite appears to be virtually independent of carbon dioxide pressure[3], and according to Stone[4] even in a dynamic atmosphere considerably less dependent than calcite on carbon dioxide pressure, thermal analyses of magnesite were carried out in the unsleeved alumina block and the nickel block. No peak displacement was found, confirming the explanation postulated above. Arising from the report by Haul and Heystek[3] that while reduction of the carbon dioxide pressure in the furnace atmosphere has no effect on the position of the first dolomite peak, it displaces the calcium carbonate peak downwards, determinations on dolomite in both the unsleeved alumina and nickel holders were carried out. These yielded the thermograms shown in curve 5, in which the coincidence of the significant portions of the first peaks, and the downward displacement of the calcium carbonate peak in the thermogram obtained using the porous holder, can be clearly seen, affording further confirmation.

The fact that the displacement of the calcium carbonate peak in the calcium hydroxide–calcium carbonate mixture is far greater than in pure calcium carbonate (curves 1 and 2) is accounted for by the same factor. In the mixture, after the hydroxide has decomposed, the resulting calcium oxide undergoes an exothermic solid-phase reaction[5] with the carbon dioxide produced in the initial stages of the decomposition of the carbonate, particularly in the hotter peripheral parts of the sample well. This exothermic reaction masks the earlier part of the endothermic decomposition of the calcium carbonate by cancellation. This effect is much more pronounced in the impervious walled nickel specimen holder than in the porous alumina cell, where much of the carbon dioxide produced is lost by diffusion.

This effect has also been observed in samples of calcium hydroxide compacted to very different densities in the nickel sample holder; as the density increases, with a consequent decrease in porosity, the peak is displaced to a higher temperature, as much as 20° C. for a change in sample bulk density of 100 per cent.

These observations illustrate the need for standardization of sample holders, the bulk density and porosity of the thermo-active material and also the geometry of the sample well as pointed out by Arens[6].

The comparison of the two types of sample holder has also shown that for endothermic reactions such as the decomposition of calcium hydroxide, calcium carbonate and magnesium carbonate, the nickel block is only slightly less sensitive than a ceramic holder. At temperatures of about 500° C., it gives peak areas which are about 80 per cent of those for the ceramic block and at about 900° C., about 70 per cent. The nickel holder yields peaks which are sharper (that is, they have a greater amplitude in relation to their width) and it also has greater resolving power (hence closely adjacent peaks can be more clearly differentiated), as illustrated in curve 5. This effect is partially due to the more definite point of inflexion on the curve where it first leaves the base-line in thermograms obtained using the nickel block. This characteristic is most clearly shown in curves 3 and 4. The fact that it also occurs in the thermogram for magnesite shows that this effect is not due to porosity. It is ascribed to the higher thermal conductivity of the nickel holder, a factor believed to operate as follows. Endothermic decomposition commences in those portions of the sample nearest the walls of the sample well, and, in the case of the nickel holder, heat is readily available from the large mass of metal of high conductivity in contact with the cooler decomposing material. Rapid heat-flow into this superficial layer masks the early part of the reaction by neutralizing the endothermic effect before it can affect the differential thermo-junction. It is for this reason that the endothermic reaction appears to start at a higher temperature in the nickel holder. When the temperature reaches a value at which the rate of decomposition becomes so rapid that the heat from the nickel can no longer penetrate the increasingly thick layer of decomposed material of low thermal conductivity sufficiently rapidly to neutralize the endothermic effect, the reaction quickly manifests itself, reaching, for the rest of the decomposition period, a rate comparable with that prevailing in the ceramic holder.

Under identical and closely controlled experimental conditions, the variations in all the significant parameters for the calcium hydroxide peak were lower in thermograms obtained using the nickel sample holder, namely, about 1 per cent compared to 2 per cent in the case of the peak areas. The temperature difference between the furnace atmosphere and the centre of the inert reference material is smaller in the nickel holder than in the ceramic, varying from respectively 25 and 40° C. at 100° C., through 11 and 28° C. at 500° C. to 4 and 12° C. at 1,000° C.

A full account of these and related findings will be published elsewhere. This communication is published by permission of the South African Council

for Scientific and Industrial Research, and acknowledgment is made to Mr. J. E. Kruger for assistance in this work.

T. L. Webb

National Building Research Institute,
Council for Scientific and Industrial Research,
Pretoria. June 18.

[1] Grimshaw, R. W., Westerman, A., and Roberts, A. L., *Trans. Brit. Cer. Soc.*, **47**, 269 (1948).
[2] Gruver, R. M., *J. Amer. Cer. Soc.*, **33**, 3, 96 (1950).
[3] Haul, R. A. W., and Heystek, H., *Amer. Min.*, **37**, 166 (1952).
[4] Stone, R. L., *J. Amer. Cer. Soc.*, **37**, 2, 46 (1954).
[5] Webb, T. L., *S.A. Indust. Chem.*, **7**, 224 (1953).
[6] Arens, P. L., Ph.D. thesis, Landbouwhogeschool, Wageningen (1951).

---

Somewhat similar experiments to those described by Mr. T. L. Webb have recently been carried out, quite independently, at the Macaulay Institute for Soil Research; but clay minerals were used for all comparisons. Porous sintered alumina and nickel specimen holders with cylindrical sample-wells and of identical dimensions, conforming to those previously described for the same apparatus[1], were used; in addition, the nickel holder could be fitted with a lid. The results corroborate those of Mr. Webb; but as they are somewhat complementary and additional observations were made, a brief note upon the findings seems desirable.

The curves obtained for the main endothermic peak of kaolinite (the 'standard' sample used for differential thermal analysis standardization[2]) using the porous alumina specimen holder, the nickel specimen holder, and the nickel specimen holder with lid are shown superposed in Fig. 1. The difference between the curves for the porous alumina and nickel holders is similar to that described by Mr. Webb for calcium hydroxide, and previously reported by Gérard-Hirne and Lamy[3] for kaolinite; namely, using the nickel holder, the peak is smaller (about 75 per cent the area of that in the alumina holder), the peak temperature is higher by about 6° C., and the peak is sharper and apparently becomes more asymmetric. The apparent asymmetry is not, however, reflected to any extent in the 'slope ratio'[4], which for both curves is approximately 1·12. Additional confirmation of Mr. Webb's hypotheses regarding the effects of nickel specimen holder upon

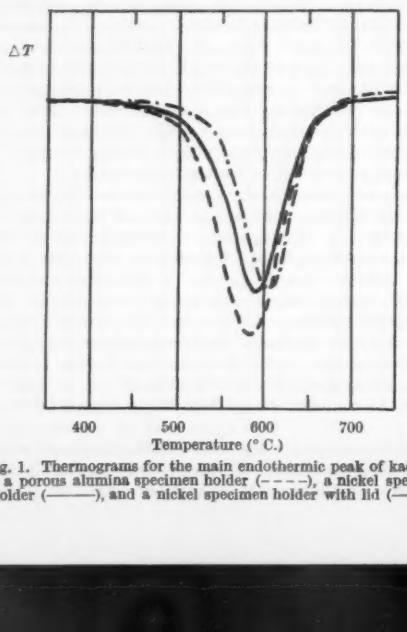



Fig. 1. Thermograms for the main endothermic peak of kaolinite in a porous alumina specimen holder (– – – –), a nickel specimen holder (———), and a nickel specimen holder with lid (—·—·)

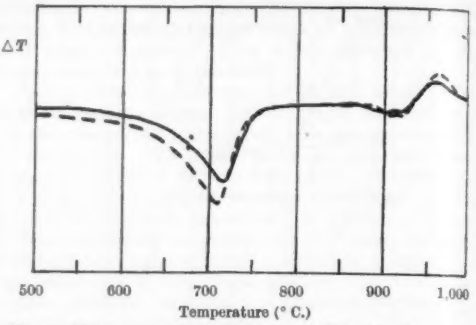



Fig. 2. Thermograms for montmorillonite (Wyoming bentonite) in a porous alumina specimen holder (– – – –) and a nickel specimen holder (———)

thermal peaks is afforded by the curve for the nickel specimen holder fitted with lid (Fig. 1). This both reduces the ease of diffusion of gaseous products away from the sample and provides an additional nickel surface in contact with the sample. Comparing the curve with that for the nickel specimen holder without lid, the expected features are observed; namely, using the lid, the peak area becomes slightly smaller (about 90–95 per cent of that without the lid), the peak temperature is higher by about 10° C., the peak is somewhat narrower, and the asymmetry increases (slope ratio about 1·30). This asymmetry would, of course, be expected because of the more rapid heat conduction into the sample from nickel than from alumina while the specimen is returning to normal base-line conditions.

There currently appears to be some confusion regarding the magnitude of exothermic peaks in nickel and alumina specimen holders; Arens[6] has claimed that exothermic peaks are smaller in ceramic specimen holders than in nickel, while Gérard-Hirne and Lamy[3] report the opposite effect. The exothermic peaks for the kaolinite samples examined in the above experiments were not particularly suited for measurements of this nature, but some experiments were carried out with Wyoming bentonite (montmorillonite), which gives a much smaller exothermic peak (Fig. 2). In the nickel specimen holder (lid off) the exothermic peak is smaller than in the alumina specimen holder in about the same proportion as the endothermic peak is smaller. This finding agrees with that of Gérard-Hirne and Lamy but not with that of Arens; it does, however, appear to conform with the different characteristics of the two holders, the heat of reaction being conducted away from the surface layers more rapidly in the nickel specimen holder.

The marked difference in position of base-line in the region below 600° C. in Fig. 2 is easily explained. After the removal of the lattice hydroxyl groups the sample has different heat characteristics and the base-line appears at a higher level. As would be expected, this displacement is larger for the alumina than for the nickel specimen holder, and as the latter parts of the base-lines are superposed the earlier parts appear at separate levels. The same effect may be observed on Mr. Webb's curve 1, where the base-lines for the earlier parts of the curves are superposed and the two curves separate after the calcium carbonate peak.

That some of the above observations appear to be at variance with those of Arens may in effect be

somewhat illusory. So many experimental factors are involved that each set of results can only strictly apply to the particular apparatus upon which they were obtained, and a rigorous comparison requires a critical survey of all available data, as well as a knowledge of the theoretical implications of the many factors concerned.

In spite of the various apparent advantages of the metal specimen holder, rigid standardization upon this type seems scarcely desirable. For example, while a metal holder is very suitable for dolomite determinations, we have found an alumina holder of low porosity gives reasonable results. For some investigations, indeed, the alumina type may be preferable; for example, the loss of 25 per cent in peak area may in certain circumstances be quite serious and not offset by increased sharpness of peak. The choice of holder, therefore, is logically related to the problem involved. On the other hand, the contributions of Arens[5] and Stegmüller[6], taken in conjunction with theory, may eventually make standardization of the geometry of the sample well, as suggested by Mr. Webb, possible. Uniform tightness of packing of specimens is more desirable and is relatively easy to obtain provided one operator performs all comparative tests; whether it can, however, be attained by two operators independently without use of elaborate apparatus is open to doubt.

In conclusion, I am grateful to Mr. Webb for sending me a copy of his note before publication, and should like to express my thanks to Mr. D. J. Greenland and Mr. U. Schwertmann for carrying out the actual determinations involved.

ROBERT C. MACKENZIE
Macaulay Institute for Soil Research,
Craigiebuckler,
Aberdeen.
July 29.

[1] Mackenzie, R. C., *An. Edafol. Fisiol. veg.*, **11**, 159 (1952).
[2] Mackenzie, R. C., and Farquharson, K. R., C.R. XIXe Congr. Géol. Internat., Alger., **18**, 183 (1952).
[3] Gérard-Hirne and Lamy, C., *Bull. Soc. franç. Céram.*, No. 10, 28 (1951).
[4] Bramão, L., Cady, J. G., Hendricks, S. B., and Swerdlow, M., *Soil Sci.*, **73**, 273 (1952).
[5] Arens, P. L., Ph.D. thesis, Landbouwhogeschool, Wageningen (1951).
[6] Stegmüller, L., *Sprechsaal*, **86**, 1 (1953).

# FREE RADICALS IN BIOLOGICAL MATERIALS

By PROF. BARRY COMMONER, JONATHAN TOWNSEND and GEORGE E. PAKE

Henry Shaw School of Botany and the Department of Physics, Washington University, St. Louis, Missouri

THE chemical activity of living cells is usually ascribed to compounds which are ordinary molecules, all the electrons of which occur in pairs. However, one of the striking results of efforts to analyse the reaction mechanisms of biological processes is the frequency with which it becomes necessary to depart from this rule. Investigation of a number of important biological processes leads to the conclusion that free radicals, that is, compounds with one or more unpaired electrons, occur as reaction intermediates.

Free radicals have been implicated as decisive participants in (*a*) biological oxidation-reductions[1,2], (*b*) the action of ionizing, ultra-violet and visible radiation on biological systems[3], (*c*) chemical carcinogenesis[4].

Although these inferences, if correct, are of far-reaching importance, all have been derived from indirect evidence and model experiments; free radicals have not been demonstrated in living things. From the fact that many free radicals are notoriously unstable, it has been supposed that free-radical intermediates formed during a biochemical process would be short-lived, and incapable of contributing to the more or less permanent components of the cell.

Until recently, the methods available for investigating free radicals were not suited to work with biological materials. This deficiency has in part been rectified recently by the development of paramagnetic resonance absorption techniques which are capable of detecting small amounts of free radicals in the presence of the large amounts of diamagnetic substance which occurs in living material. The present communication reports investigations based on this new technique. The results show that free radicals occur in plant and animal tissues, and provide evidence relating free radicals to metabolic activity and certain photochemical processes. Contrary to expectation, it has been found that some biological free radicals, such as melanin, are extraordinarily stable.

Paramagnetic resonance absorption is due to the unpaired electrons associated with free radicals. Experimental techniques and apparatus for detecting it have been described elsewhere[5]. Biological material is lyophilized and the resulting powder inserted into the absorption chamber of the apparatus. Typical results are illustrated in Figs. 1 and 2. The area under the absorption curve is proportional to the number of unpaired electrons in the sample, and the free-radical content of biological materials may be evaluated in this manner.

Table 1 lists the estimated free-radical content of a number of tissues. Certain significant differences are apparent. Most notable is the high free-radical content found in metabolically active tissues, such as the green leaf, liver and kidney. The extraordinarily high value of frog eggs is due to the presence of melanin, which is a free radical. The paramagnetic resonance absorption of lyophilized tissue persists for months under refrigeration.

Fractionation experiments show that the paramagnetic resonance absorption generally found in tissues is associated with protein components and

Table 1

| Material | Estimated free radical content (moles × $10^9$/gm. dry weight*) |
|---|---|
| *Nicotiana tabacum*, leaf | 65 |
| *Nicotiana tabacum*, roots | 10 |
| *Coleus*, leaf | 180 |
| Barley, leaf | 25 |
| Snapdragon, petals | 8 |
| *Digitalis*, germinating seeds | 10 |
| Carrot, root | 8 |
| Beet, root | 6 |
| Bracket fungus | 35 |
| Rabbit, whole blood | 25 |
| Rabbit, muscle | 20 |
| Rabbit, brain | 25 |
| Rabbit, liver | 60 |
| Rabbit, lung | 30 |
| Rabbit, heart | 35 |
| Rabbit, kidney | 55 |
| Mouse, liver | 30 |
| Mouse, liver hepatoma | 20 |
| Guppies, entire | 2 |
| Frog, unfertilized eggs | 200 |
| *Drosophila*, entire | 4 |
| Firefly, lanterns | 2 |

* These values are based on comparison of the absorption given by approximately 0·5-gm. samples with the absorption given by $10^{-5}$ mole of diphenyl picryl hydrazyl free radical under identical instrumental conditions.

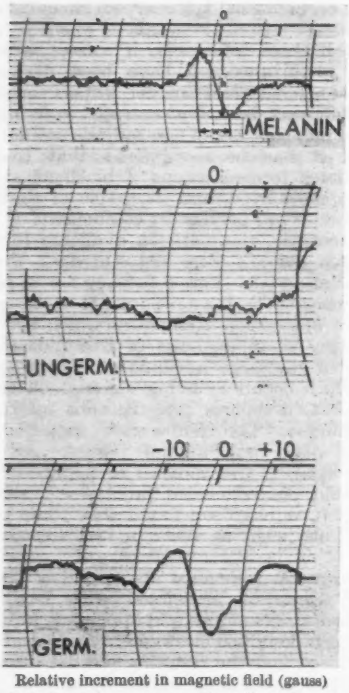



Fig. 1. Paramagnetic resonance absorption given by 1-gm. samples of lyophilized digitalis seeds before germination, and just after emergence of the primary root. Magnetic field increases towards the right along the abscissa, with point marked zero representing position of paramagnetic resonance absorption given by a standard free radical, diphenyl picryl hydrazyl. Ordinate represents the rate of change, with respect to field strength, of microwave energy (9,000 Mc./sec.) absorbed by the sample, as the field-strength is varied

For comparison, the uppermost curve shows the paramagnetic resonance absorption given by a stable free radical (melanin). The presence of unpaired electrons associated with the free radical results in absorption of incident microwave energy when the varying external magnetic field reaches about 3,000 gauss (point marked zero). The apparatus records the derivative of the absorption curve, and free radical content can be estimated from the quotient $h \times w^2$

that denaturation of the protein destroys the free radicals.

In the light of the suggestion of Michealis[1] and others that free radicals occur as intermediates in biological electron-transfer processes, it is of considerable interest to investigate the association between free radical content and metabolic activity. We find that initiation of active metabolic processes in dried yeast preparations increases the free-radical content significantly. There is similar evidence that free radicals are formed as a result of the increased metabolic activity induced by germination of seeds (Fig. 1).

Etiolated barley leaves show only about one-fifth the paramagnetic resonance absorption observed in fully green leaves. Fig. 2 shows that when etiolated leaves are exposed to 100 ft. candles of illumination from fluorescent lights, the original paramagnetic resonance absorption increases remarkably within six hours. After 24 hr. of illumination, during which time the leaves become fully green, it reaches the magnitude observed in normal light-grown leaves. Thus, the large paramagnetic resonance absorption observed in the green leaf is a result of photochemically induced formation of free radicals. This process may be associated with the synthesis of chlorophyll, for Smith[6] finds evidence that a free radical may occur as an intermediate in the photochemical conversion of protochlorophyll into chlorophyll. Preliminary investigations have been carried out to determine whether the paramagnetic resonance absorption of fully green leaves changes during illumination. The results obtained thus far show that such an effect, if it exists, must be small. The above data tend to support Michealis's proposal[1] that metabolic electron transfer induces the formation of a small steady-state concentration of free radicals.

The occurrence of paramagnetic resonance absorption in melanin suggested that similar polymeric products of biological origin be examined for free radicals. A series of natural products of this type have been studied. Paramagnetic resonance absorption has been detected in the following: gum guaiacum, liquorice (powdered root of *Glycyrrhiza*), humin (from protein hydrolysis), various plant resins, caramelized glucose, charcoals of organic origin, various types of coal and tars. The free radicals associated with these products all appear to be indefinitely stable at room temperature, and a number resist heating. The paramagnetic resonance absorption of melanin resists 24 hr. of refluxing in hydrochloric acid.

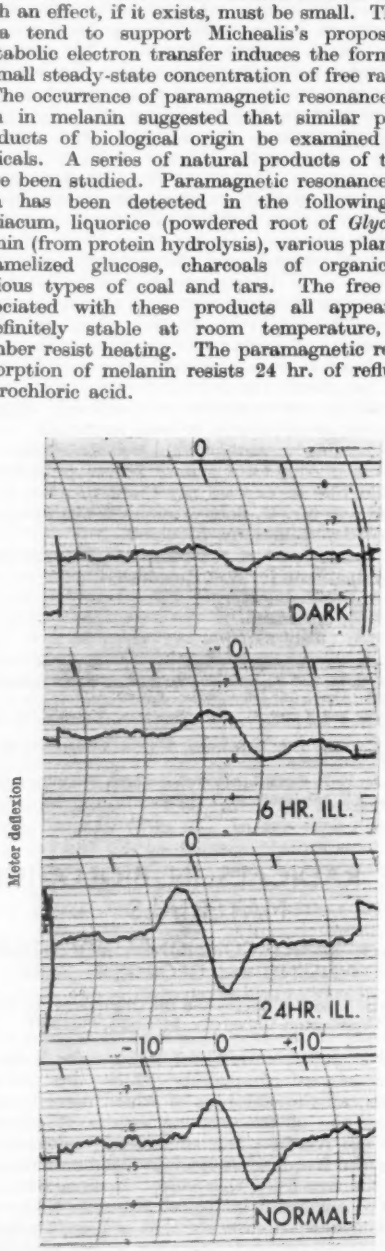



Fig. 2. Paramagnetic resonance absorption of 0·65-gm. samples of leaves from barley seedlings. Uppermost curve: etiolated. Lowermost curve: leaves from comparable seedlings grown in light. Centre curves: etiolated leaves after 6 and 24 hr. of illumination. Ordinate and abscissa as in Fig. 1

Despite their apparent heterogeneity, the natural products containing unpaired electrons have a characteristic in common: all these materials contain polymeric condensed ring structures. The plant products listed above are all highly polymerized condensed ring structures. The same is true of melanin. Recent investigations on the structure of coal[7] show that condensed ring polymers resembling the graphite structure constitute a large portion of the material. These polymeric aggregates apparently account for the roughly spherical particles, about 0·05 $\mu$ in diameter, which are seen in electron micrographs of ethylene diamine extracts of coal[8]. We find distinct paramagnetic resonance absorption in such coal extracts. It is likely that similar aggregates also occur in tars, caramels and other organic materials which have been carbonized by heat or by other means.

It is suggested that unpaired electrons generated during reactions which lead to these condensed ring products (that is, melanin, gums, resins, coal) become trapped and stabilized in the polymer lattice. Similarly, unpaired electrons resulting from carbonization by heat, or by strong acid, may become incorporated into the graphite-like aggregates which are formed. That such polymers have a high affinity for unpaired electrons, and thereby form stable free radicals, is to be expected from recent observations that the electron affinity of a series of condensed ring substances increases considerably with the size of the molecule[9].

While these preliminary observations do not offer an explanation for these phenomena, they do show that unpaired electrons may occur in highly stable configurations in substances of considerable biological interest.

These results show that tissues contain two types of free radicals: (*a*) tissues possess free radicals apparently associated with protein moieties, which are heat-labile, occur in the concentration range of $10^{-6}$–$10^{-8}$ mole of free radical per gm. of tissue, and which appear to increase in amount during metabolic activity; (*b*) a number of polymeric condensed-ring substances, such as melanin, which are characteristic products of certain organisms, contain unpaired electrons in a highly stable configuration.

Certain broad conclusions can be derived from these observations. The properties of the labile free radicals which we have detected are consistent with Michealis's characterization of the free radicals generated by oxidative metabolism: (*a*) they appear to be associated with proteins; (*b*) they attain concentrations which vary with the level of metabolic activity; and (*c*) the range of free-radical content, $10^{-6}$–$10^{-8}$ mole/gm. of tissue, is of the order of magnitude expected from McIlwain's estimation[10] of the total electron carrier content of tissues ($10^{-5}$–$10^{-6}$ mole/gm.). Furthermore, measurements of paramagnetic resonance absorption confirm the suggestion[1] that electron carriers such as riboflavin and pyocyanin are capable of forming free radicals. While these observations do not constitute proof of Michealis's proposals, they do provide both incentive and experimental opportunities for more intensive investigations of this problem.

The discovery of unpaired electrons in melanin is indirect evidence that free radicals are formed by irradiation of biological systems, for it has been shown that melanin formation in animals may be induced by ultra-violet and ionizing radiation[11]. Paramagnetic resonance absorption induced by illumination of etiolated leaves is direct evidence for such an effect.

The discovery that certain common biological products are extraordinarily stable free radicals raises a number of intriguing questions concerning the physical chemistry of substances such as melanin and resins, and also poses problems of concern to the biologist. If the unpaired electrons in such polymers are not continuously accessible to the reaction mechanisms of the cell, these substances can be thought of as dumping grounds for unpaired electrons. In this case they may influence the course of cellular metabolism by irreversibly removing unpaired electrons generated by oxidation-reduction or photochemical processes. In this connexion the induction of melanin formation by ultra-violet or ionizing radiation may be construed as a protective mechanism which, by sequestration of photon-generated unpaired electrons in an inactive configuration, forestalls more violent effects of irradiation on the cell. An alternative approach would be required if it is found that the unpaired electrons in condensed ring polymers react readily with metabolic components of the cell. This would suggest the possibility that electron transfers between metabolic intermediates may take place by a quasi-metallic conduction of electrons through the intervening condensed ring structures. From this point of view it is significant to note that the wave function of an unpaired electron associated with a condensed ring molecule appears to extend throughout a region which encompasses most of the structure[12]. The electron may therefore be considered to be highly mobile within the structure, and thereby capable of mediating conduction within it. This proposal would become especially important if it were found that enzyme proteins are capable of holding stable unpaired electrons. Such an observation would support Szent-György's suggestion[13] that cellular oxidation-reduction processes involve electron-transfer through a protein continuum.

We are indebted to Mr. James A. Warnhoff for assistance in conducting these investigations, and to Dr. S. I. Weissman for many helpful discussions of this material.

This work was done under Contract *N6onr*-20206, with the Office of Naval Research. [July 12.

[1] Michealis, L., in "The Enzymes", edit. by Sumner, J. B., and Myrback, K., 2, Part 1, chapter 44 (Academic Press, New York, 1951).

[2] Michealis, L., and Schubert, M. P., *Chem. Revs.*, **22**, 437 (1938). Haas, E., *Biochem. Z.*, **290**, 291 (1937). Waters, W. A., "Chemistry of Free Radicals" (Oxford, 1948).

[3] Weiss, J., *Nature*, **157**, 584 (1946). Gray, L. H., "Progress in Biophysics", **2**, 240 (1950). Rabinowitch, E. I., "Photosynthesis and Related Processes", 1 (Interscience Publishers, New York, 1945). Calvin, M., *Chem. and Eng. News*, **31**, 1735 (1953). Evenari, M., and Stein, G., *Experientia*, **9**, 94 (1953).

[4] Kensler, C. J., Dexter, S. O., and Rhoads, C. P., *Cancer Res.*, **2**, 1 (1942). Park, H. F., *J. Phys. and Coll. Chem.*, **54**, 1383 (1950). Fitzhugh, A. F., *Science*, **118**, 783 (1953).

[5] Gordy, W., Smith, W. V., and Trambarulo, R. F., "Microwave Spectroscopy" (Wiley, New York, 1953).

[6] Smith, J. H. C. (personal communication).

[7] Van Krevelen, D. W., C.R. Troisième Cong. pour l'avancement des études de stratigraphie et de géologie du carbonifère, **1**, 369 (Éditions Van Aelst, Maestricht, 1952).

[8] Ellis, C., *Proc. Roy. Soc.*, B, **139**, 449 (1952).

[9] Paul, D. E., thesis, Washington University, St. Louis (1953).

[10] McIlwain, H., *Nature*, **158**, 898 (1946).

[11] Blum, H. F., in "The Biology of Melanomas", **4**, 388 (New York Academy of Sciences, New York, 1948).

[12] Weissman, S. I., Townsend, J., Paul, D. E., and Pake, G. E., *J. Chem. Physics*, **21**, 2227 (1953).

[13] Szent-Györgyi, A., "Chemistry of Muscular Contraction" (Academic Press, New York, 1947). Leach, S. J., "Adv. in Enzymology", **15**, 1 (1954).

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Synthesis of Sucrose by a Partially Purified Plant Tissue Extract

It was reported previously[1] that a crude extract obtained from peas formed sucrose when incubated with a mixture of glucose-1-phosphate and fructose. Evidence was presented that the sucrose synthesis was not due to a simple reaction between glucose-1-phosphate and fructose as catalysed by bacterial sucrose phosphorylase[2]. In the present communication the results of some experiments with a partially purified pea extract are briefly described. Since this work was carried out, Leloir and Cardini have reported[3] the extraction from wheat germ of an enzyme which catalyses the reaction

uridine diphosphate glucose + fructose ⇌ sucrose + uridine diphosphate.

It is probable that this reaction is the final step in sucrose formation from glucose-1-phosphate and fructose by pea extracts.

The partially purified extract was obtained by the addition of ammonium sulphate (to 80 per cent saturation) to the crude pea extract, suspension of the precipitate in water and subsequent dialysis against 0·025 *M* phosphate buffer of *p*H 7·0 at 4° C. No sugars or phosphoric compounds (other than inorganic phosphate) were detected when trichloracetic acid extracts of the preparation were examined on paper chromatograms.

This dialysed extract, unlike the crude extract used previously, did not synthesize sucrose from glucose-1-phosphate and fructose; but this activity could be restored by the addition of the boiled crude pea extract, The dialysed extract was stable for two days at 4° C. and for seventeen days at − 15° C.

The addition of magnesium chloride to enzymic digests containing the dialysed extract, glucose-1-phosphate, fructose and boiled crude pea extract was found to increase sucrose formation. No sucrose was formed with magnesium chloride unless boiled crude pea extract was added. It was therefore concluded that the boiled crude pea extract contained a factor or factors, other than magnesium ions, essential for the synthesis of sucrose.

The boiled crude pea extract could be replaced by nucleotide fractions prepared from peas or yeast. Peas (or yeast) were extracted with hot aqueous alcohol, the nucleotides precipitated with mercuric acetate and the precipitate decomposed with hydrogen sulphide in the cold. The mercuric sulphide was filtered off and the filtrate aerated and neutralized to *p*H 7·0. No free sugars were detected in these nucleotide fractions when samples were examined on paper chromatograms.

The formation of sucrose from glucose-1-phosphate and fructose in the presence of the dialysed pea extract, yeast nucleotide fraction and magnesium chloride is shown graphically in Fig. 1. After 41·6 hours, fructose had decreased to nearly zero, and the loss of this sugar was approximately 4·5 times that required to account for fructose appearing in the sucrose formed. The progress of the reaction is also shown in the chromatogram in Fig. 2. It has been possible to prepare in crystalline form a sample of sucrose, which must have been synthesized since none was present in the dialysed extract or nucleotide fractions.

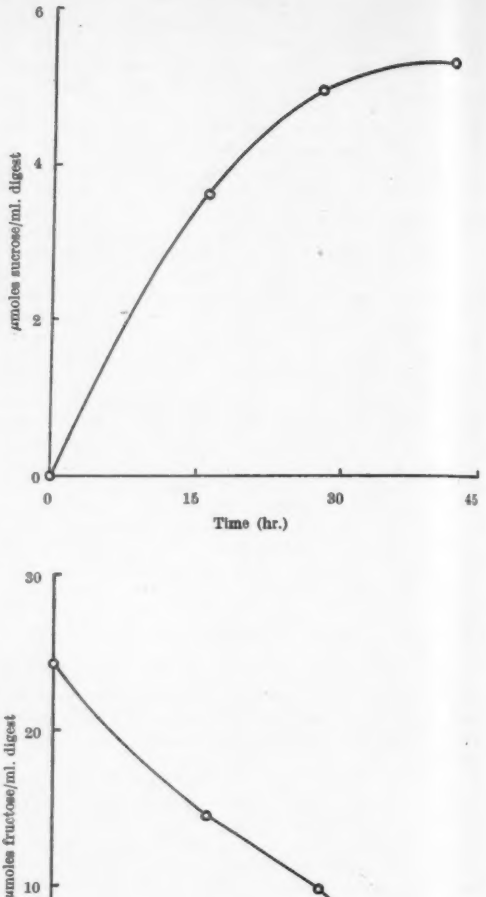



Fig. 1. The formation of sucrose and the loss of fructose in a digest containing the dialysed pea extract. Digest: glucose-1-phosphate, 0·0144 *M*; fructose, 0·0244 *M*; $MgCl_2$, 0·01 *M*; yeast nucleotide fraction, 0·5 ml.; dialysed pea extract, 1 ml.; total volume, 1·8 ml. *p*H 7·0, 25° C.

It was found that in enzymic digests containing the dialysed pea extract and the nucleotide fractions, *less* inorganic phosphate was liberated when fructose was added than with glucose-1-phosphate alone as substrate. As already reported, the addition of fructose to digests containing the crude pea extract and glucose-1-phosphate produced an increased liberation of inorganic phosphate[1].

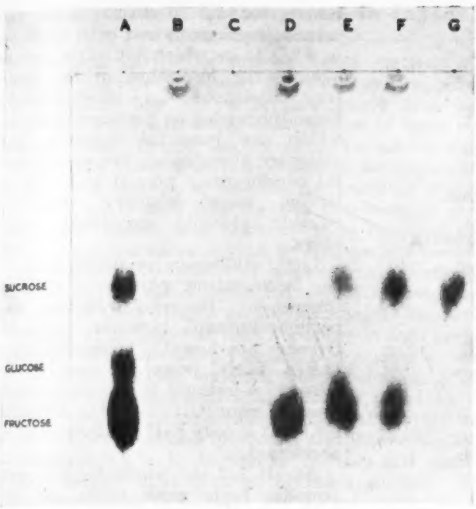



Fig. 2. Chromatogram of sugars showing formation of sucrose by the dialysed pea extract. Digest as in Fig. 1. *A*, solution containing sucrose, glucose and fructose; *B*, *C*, digest without fructose after 1 min. and 41·6 hr. respectively; *D*, *E*, *F*, *G*, digest with fructose after 1 min., 16 hr., 27·6 hr. and 41·6 hr. respectively. Whatman No. 1 paper. Solvent, *n*-propyl alcohol (80 vol.)/water (15 vol.)/ammonia (5 vol.). Running time, 18 hr. $AgNO_3$–NaOH spray (ref. 4)

Sucrose synthesis was decreased when the enzymic reaction was carried out in the absence of oxygen. In an atmosphere of nitrogen, synthesis was inhibited by 81 per cent; *in vacuo* the inhibition was 86 per cent.

Glucose-1-phosphate could be replaced by glucose-6-phosphate or fructose-6-phosphate as substrate for sucrose formation. This was to be expected as the pea extract contained phosphoglucomutase and phosphohexoisomerase. As the extract also contained amylose phosphorylase, starch (plus inorganic phosphate) was able to replace glucose-1-phosphate. Fructose could not be replaced by fructose-1-phosphate, fructose-6-phosphate or fructose-1,6-diphosphate.

The coenzyme activity of the pea and yeast nucleotide fractions was acid-labile and the effect of heating with 0·1 *N* hydrochloric acid suggested that diphosphopyridine nucleotide might be involved. Factors which were more acid-stable were also present. In subsequent experiments it was found that the nucleotide fractions could be replaced by a mixture of diphosphopyridine nucleotide, uridine monophosphate and adenosine triphosphate.

Several experimental results, including the requirement of diphosphopyridine nucleotide and adenosine phosphates, the esterification of inorganic phosphate and the formation of fructose-1,6-diphosphate and carbon dioxide by the enzymic digests, are readily explained if it is assumed that a glycolytic system was operating during sucrose formation.

It has been suggested that free hexoses are not intermediates in sucrose formation in plants[5,6]. Buchanan[7] has proposed that uridine diphosphate glucose and fructose-1-phosphate react to give sucrose phosphate, which is then converted to free sucrose. The results of the present experiments with peas are consistent with the hypothesis that uridine diphosphate glucose is involved (this substance may be formed from glucose-1-phosphate and uridine triphosphate[8] and the latter compound may be produced from uridine monophosphate through the operation of a glycolytic system); but it appears that free fructose (and not a phosphoric ester of this sugar) is an intermediate in the sucrose synthesis. This is in agreement with the results obtained with extracts from wheat germ[3].

I wish to express my indebtedness to Dr. L. W. Mapson, and to Prof. C. S. Hanes and Dr. F. A. Isherwood.

Financial assistance was provided initially by the Australian Commonwealth Scientific and Industrial Research Organization, and the work was continued during the tenure of a Broodbank Fellowship of the University of Cambridge. Support from these two sources is gratefully acknowledged.

J. F. Turner*

Botany School,
Cambridge.

* Present address: Division of Food Preservation and Transport, C.S.I.R.O., Homebush, N.S.W., Australia.

[1] Turner, J. F., *Nature*, **172**, 1149 (1953).
[2] Doudoroff, M., Kaplan, N., and Hassid, W. Z., *J. Biol. Chem.*, **148**, 67 (1943).
[3] Leloir, L. F., and Cardini, C. E., *J. Amer. Chem. Soc.*, **75**, 6084 (1953).
[4] Trevelyan, W. E., Procter, D. P., and Harrison, J. S., *Nature*, **166**, 444 (1950).
[5] Calvin, M., and Benson, A. A., *Science*, **109**, 140 (1949).
[6] Hassid, W. Z., and Putman, E. W., *Fed. Proc.*, **11**, 226 (1952).
[7] Buchanan, J. G., *Arch. Biochem. Biophys.*, **44**, 140 (1953).
[8] Kornberg, A., "Phosphorus Metabolism", **1**, 410 (Johns Hopkins, 1951).

## A Model System for the Olfactory Membrane

In the course of investigations on the kinetics of lysis of red blood cells by saponin and other hæmolytic agents, we have studied the effect of the addition of small amounts of various odorants. We describe below the unusual powers such adjuvants have in accelerating the process of hæmolysis. Somewhat remarkably, the activities of the odorants in this respect are paralleled by their activities in stimulating the olfactory cell membrane. This finding lends support to a theory of olfactory stimulation[1] which envisages 'puncturing' of the olfactory cell membrane by the odorant molecules.

Although little is known about the structure and composition of the olfactory cell membrane, there is reason to believe that it consists of orientated layers of cholesterol, phospholipids and proteins[2]. The layer may possibly only be bimolecular and yet remain impermeable to ions. In certain nerve cells it has been shown that there is an excess concentration of potassium ion inside, and an excess of sodium outside the cell. The cell membrane maintains its continuity by being partly liquid, some rigidity being provided, however, by cholesterol molecules and protein. The state of affairs is probably similar for the olfactory nerve cells. As a model, the red cell possesses the experimental advantage that, on penetration of the cell wall (and here again the lipids may form a bimolecular envelope[3]), the hæmoglobin is released.

It is found that, in the concentration-range studied, odorous substances act as weak hæmolysants. Thus a 0·005 *M* solution of skatol in isotonic buffered

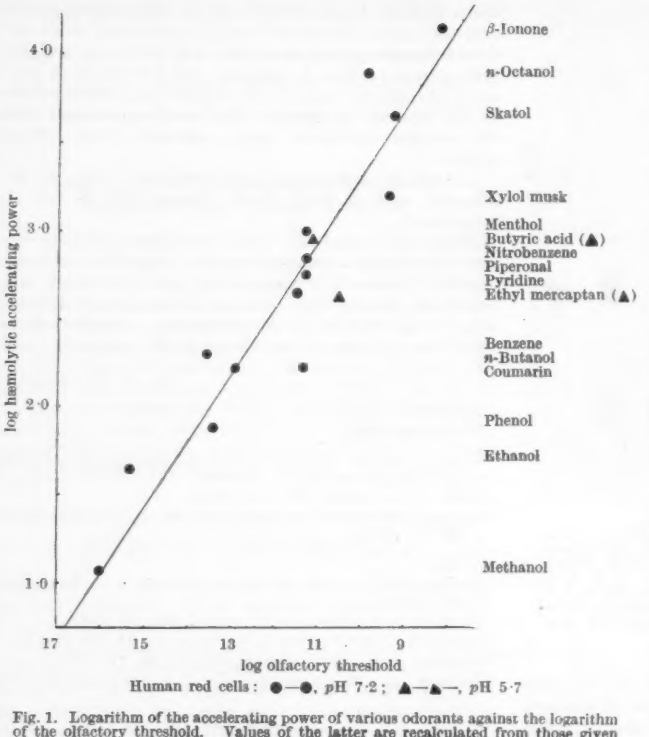



Fig. 1. Logarithm of the accelerating power of various odorants against the logarithm of the olfactory threshold. Values of the latter are recalculated from those given in the experimental literature. Experiments were carried out at 25° C.

saline at *p*H 7·2 and 35° C. took 60 min. to hæmolyse a dilute suspension of human red blood cells. Ponder[4] has reported that an indole solution containing 1 m*M*/l. completely hæmolyses a suspension of rabbit red cells in 30 min. at *p*H 6·3 and 25° C. A similar concentration of a strong hæmolysant such as saponin is effective in a few seconds.

We have found, however, that all the odorants tested acted as accelerators for hæmolysis by saponin. The exact mechanism by which these accelerators act is still under investigation; but the evidence indicates that the accelerant molecules interact with some component of the erythrocyte membrane, weakening it and facilitating the process of penetration by the saponin. This is in accordance with the findings of Ponder[4].

As a measure of the accelerating power of the odorant, the quantity

$$A = \frac{\left(\frac{1/T}{1/T_0} - 1\right)}{c}$$

was taken, where $A$ is accelerating power, $c$ is molar concentration of odorant, and $T$ and $T_0$ are the times for the sample to undergo hæmolysis with and without odorant respectively.

The accelerating power is a measure of the extent to which the cell wall is weakened by the odorant. If the model is a good one, and if it is true that the odorant molecule is adsorbed on to and penetrates the olfactory cell wall, then we may expect a relation between the olfactory threshold and the accelerating power for hæmolysis. That this correlation does indeed exist is shown in Fig. 1, in which log $A$ is plotted against the logarithm of the olfactory threshold (in molecules/c.c.). Substances such as β-ionone or skatol, which are powerful odorants (low olfactory thresholds), are also powerful accelerants; phenol and ethanol, having large olfactory thresholds (weakly odorant), are weak accelerators.

Little difference is found between the accelerating powers of *dl*- and *l*-menthol. Between *n*-butanol and perfluorobutanol, however, large differences are found; perfluorobutanol has a fairly powerful camphor-like odour; *n*-butanol is a comparatively weak odorant (O.T. = $8{\cdot}2 \times 10^{12}$ mol./c.c.) and is only half as effective as an accelerant.

At *p*H 7·2 the points for two compounds, both weak acids, lie well below the line; they appear less powerful accelerators than might be expected. This anomaly has been resolved by repeating these experiments at *p*H 5·7, when both additives exist entirely in the non-ionized form.

A series of isomeric methyl coumarins (kindly provided by Prof. Passerini) has also been investigated. It is found that 4-methyl coumarin, which is almost odourless, has less accelerating power than the other, and more strongly odorous, methyl coumarins.

Experiments with sodium decyl sulphate in place of saponin show that the odorants have similar accelerating effects on the hæmolysis.

We conclude that the structure and composition of the red cell membrane are such as to make it a good model for the surface of the olfactory cell. In view of the correlation shown in Fig. 1, and since hæmolytic acceleration is believed to entail penetration into the cell membrane with consequent weakening of the cell wall, we consider that our results lend support to the theory of olfaction which interprets the initiation of the olfactory stimulus in terms of such a process[1].

A full account of our findings will be published elsewhere.

J. T. Davies
F. H. Taylor

Department of Physical Chemistry,
King's College,
University of London,
Strand,
London, W.C.2.
June 14.

[1] Davies, J. T., *Inter. Perfumer*, **3**, No. 9 (1953); Industries de la Parfumerie, **8**, No. 3 (1953).
[2] Moncrieff, R. W., "The Chemical Senses" (Leonard Hill, London, 1951).
[3] Gorter, E., and Grendel, F., *J. Exp. Med.*, **41**, 439 (1925). Davson, H., and Danielli, J. F., "The Permeability of Natural Membranes" (Cambridge, 1951).
[4] Ponder, E., *Proc. Soc. Exp. Biol. Med.*, **38** (1939); *J. Gen. Physiol.*, **25**, 247 (1941); **27**, 1 (1943). "Hæmolysis and Related Phenomena" (J. and A. Churchill, London, 1948).

## Detection of Carbohydrase in Paper Electrophoresis

THE task of testing and localizing enzymes in a protein mixture subjected to paper electrophoresis is a tedious one. This is particularly true in a fractionation study where the number of tests may be numerous. During the course of such an investigation of the various carbohydrases in an *Aspergillus niger* fermentation, it became necessary to employ a rapid qualitative test for the detection of these enzymes. Keilin and Hartree[1] have reported that glucose oxidase (notatin) can be successfully used for the quantitative assay of various carbohydrases. Monod and Torriani[2] employed notatin to determine glucose in their studies of amylomaltase. Recently, Whistler *et al.*[3] showed that D-glucose in corn syrups can also be quantitatively estimated by using notatin. The latter enzyme oxidizes glucose to yield two products—gluconic acid and hydrogen peroxide.

We were interested in detecting qualitatively two enzymes, maltase and invertase, and if possible limit dextrinase. The hydrolysis of maltose and sucrose (and possibly limit dextrin) liberates glucose. The latter is oxidized by notatin, and the resulting gluconic acid can be detected by spraying with an alcoholic solution of bromcresol purple or any suitable indicator dye. Control experiments showed that five gammas of gluconic acid or glucose could be easily detected on filter paper. The enzymatic activity of fifty gammas (equivalent to twenty gammas of protein) of crude material could be detected with ease. Appropriate blanks indicated that notatin in the presence of various substrates gave negative results.

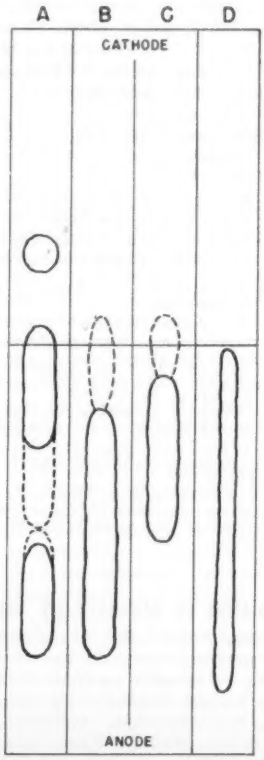



Fig. 1. Schematic reproduction of a paper electrophoresis experiment of the culture medium from *Aspergillus niger*. (*A*) The protein pattern; (*B*) the zone of maltase activity; (*C*) the zone of invertase activity; and (*D*) the zone of limit dextrinase activity

The method finally used was as follows. A freeze-dried preparation of the fermentation medium was subjected to filter-paper electrophoresis, as described by Kunkel and Tiselius[4], using a phosphate buffer, ionic strength 0·1 and *p*H 6·9. Four spots of the enzyme solution were applied to the middle of the paper (Whatman 3 *MM*) at 2·5-cm. intervals. After the completion of the run, the paper was cut longitudinally into four strips. One strip was stained with bromophenol blue[4] in order to ascertain the protein areas. While still damp (the strips were not allowed to dry out), the three remaining strips were sprayed with the following solutions: (1) a mixture of equal volumes of 2 per cent maltose and 0·5 notatin ('Dee O', obtained from Takamine Laboratory, Inc., Clifton, New Jersey, U.S.A.) for maltase activity, (2) a solution of equal portions of 2 per cent sucrose and 0·5 per cent notatin for invertase activity, and (3) for limit dextrinase activity a mixture containing 2 per cent limit dextrin and 0·5 per cent notatin was used. Each strip was covered with an eighth-inch wide mask while applying the above solutions in order to decrease excessive diffusion of the aqueous reagents. The strips were then clamped between two glass plates and incubated at 30° C. for half an hour, after which they were removed and dried at 110° C. Finally, the papers were sprayed with a solution of bromcresol purple (0·06 per cent in 95 per cent ethanol). The areas of enzymatic activity appeared as bright yellow spots on a bluish-grey background (Fig. 1).

This test should prove useful in detecting the presence of any carbohydrase which yields glucose as one of the end-products, and for this reason its application could be widely used.

L. R. WETTER
JUNE J. CORRIGAL

National Research Council
Prairie Regional Laboratory,
Saskatoon, Saskatchewan.
June 14.

[1] Keilin, D., and Hartree, E. F., *Biochem. J.*, **42**, 230 (1948).
[2] Monod, J., and Torriani, A. M., *Ann. l'Inst. Pasteur*, **78**, 65 (1950).
[3] Whistler, R. L., Hough, L., and Hylin, J. W., *Anal. Chem.*, **25**, 1215 (1953).
[4] Kunkel, H. G., and Tiselius, A., *J. Gen. Physiol.*, **35**, 89 (1951).

## The *d-iso*Citric Lyase System: the Formation of Glyoxylic and Succinic Acids from *d-iso*Citric Acid

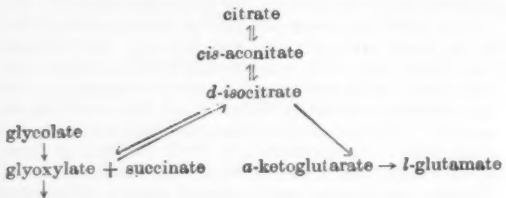
DURING studies on the acetate metabolism of *Penicillium chrysogenum* in this Department, it was found that alcoholic extracts of acetate-grown mycelium contained considerable quantities of glutamic acid and glycine, as well as a number of other metabolites[1].

In the course of this work, it was noted that citric acid disappeared rapidly on incubation with cell-free extracts of *P. chrysogenum* in the presence of arsenite, and that glutamate, α-ketoglutarate, glycine, glyoxylate and succinate formed. By varying the experimental conditions, it could be shown that citrate underwent cleavage along at least two pathways: (1) a complete breakdown to glutamate and α-ketoglutarate in fresh extracts fortified with magnesium chloride, arsenite, and a catalytic amount of TPN (not DPN); (2) a quantitative conversion to gly-

oxylate and succinate in aged (4 hr., 0° C.) or dialysed extracts in the presence of semicarbazide. If arsenite was used in place of semicarbazide, less glyoxylate accumulated and a large amount of glycine formed. Although the extracts were incubated aerobically, no oxygen was consumed.

The conversion of citrate to glyoxylate and succinate was found to be reversible. While the extracts to a limited extent were capable of oxidizing glycolate to glyoxylate, no citrate was formed in their presence from glycolate and malate. Furthermore, no detectable *d-iso*citric dehydrogenase activity was observed under conditions which were optimal for glyoxylate formation. On the basis of extensive inhibition experiments with α,α′-dipyridyl, trans-aconitate, ethylene diamine tetra-acetate, and potassium cyanide, it is considered probable that *d-iso*citrate is the immediate precursor of the cleavage products.

These reactions might be summarized as follows :




In the above scheme the direction of the arrows indicates the reactions identified, and does not necessarily relate to the reversibility of any individual reaction.

The enzyme system involved in the formation of glyoxylate and succinate from *d-iso*citric acid has been termed the *d-iso*citric lyase system. It has been found as well in extracts of baker's yeast, *Aspergillus niger* and *Rhizopus* sp. Further study on the characterization of the reaction system and on the isolation of its enzymic components is being carried out at the present time.

Glyoxylate has been known as a mould metabolite for many years[2], but the mechanism of its biosynthesis has remained obscure. The above-described reactions, demonstrating its facile formation from citrate by a cell-free enzyme extract of *P. chrysogenum*, indicate one possible pathway of its biosynthesis. In view of the fact that glyoxylic acid can be readily converted to glycine enzymatically[3], this reaction sequence may also account for the accumulation of glycine in the intact mould mycelium after incubation with acetate. The formation of glyoxylate from acetate has been suggested by Challenger[4], who found that glyoxylate and oxalate accumulated in the medium when *A. niger* was grown on calcium acetate. Whether or not glyoxylate has any function in the formation of oxalate remains to be seen.

Recently, while this work was in progress, Campbell[5] demonstrated the occurrence of an enzyme system in sonic extracts of *Pseudomonas aeruginosa* similar to that described above. This enzyme system converted citrate and *cis*-aconitate to glyoxylate and succinate, but *iso*citrate did not appear to be an intermediate.

Enzyme extracts were prepared at − 10° C. by means of Hughes' press[6] from frozen washed mycelium of *P. chrysogenum Q*176 grown in stirred aerated stainless steel fermenters[15] on an acetate salt medium and harvested in the late logarithmic phase. The crushed mycelial mass was centrifuged at 15,000 *g* for 20 minutes at + 2° C. The supernatant was frozen and stored at − 20° C., in which condition the enzyme system was stable for at least a month.

Glyoxylic acid was identified by the chromatographic behaviour, alkali instability, and characteristic spectrum of its 2 : 4-dinitrophenylhydrazone[7,8], and was crystallized from the reaction medium as its 2 : 4-dinitrophenylhydrazone, m.p. 189–192°, mixed m.p. 190–192°. Succinic acid was identified by its $R_F$ values in several solvent systems and was estimated with a succinoxidase preparation[9]. Citrate was determined by the method of Taylor[10], *l*-glutamic acid with a carrot decarboxylase preparation[11], and total hydrazones by the general extraction procedure of Friedman and Haugen[12].

I am greatly indebted to Dr. D. Cavallini for a sample of the 2 : 4-dinitrophenylhydrazone of glyoxylic acid, and to Dr. C. B. Anfinsen for generous gifts of *cis*-aconitic anhydride and crystalline dimethyl *d-iso*citric lactone, observed m.p. 102–104°, reported m.p. 104–106° [13]. After mild alkaline hydrolysis of the lactone, the specific rotation of the molybdate complex of free *d-iso*citric acid was − 760° $[\alpha]_D$ = − 745° [14]. All other reagents were analytical grade commercial products.

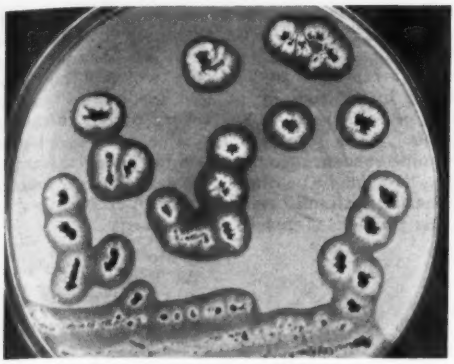
A detailed account of these experiments is to be published elsewhere. I wish to express my sincere appreciation to Prof. E. B. Chain for his continued interest and helpful advice and for the hospitality of his laboratory, and to Prof. Domenico Marotta, director of the Istituto Superiore di Sanità, for his co-operation and support during the course of this work.

J. A. Olson
(Fellow of the National
Foundation for Infantile Paralysis)
Laboratorio di Chimica Biologica,
Istituto Superiore di Sanità,
Viale Regina Margherita, 299,
Rome.
Aug. 27.

[1] Olson, J. A., and Chain, E. B. (in preparation).
[2] Dakin, H. D., *J. Biol. Chem.*, **1**, 271 (1906).
[3] Tolbert, N. E., and Cohan, M. S., *J. Biol. Chem.*, **204**, 649 (1953).
[4] Challenger, F., Subramaniam, V., and Walker, T. K., *J. Chem. Soc.*, 200 (1927).
[5] Campbell, J. J. R., Smith, R. A., and Eagles, B. A., *Biochim. Biophys. Acta*, **11**, 594 (1953).
[6] Hughes, D. E., *Brit. J. Exp. Path.*, **32**, 97 (1951).
[7] Cavallini, D., Frontali, N., and Toschi, G., *Nature*, **163**, 568 (1949).
[8] Cavallini, D., *Ricerca Sci.*, **20**, 803 (1950).
[9] Krebs, H. A., *Biochem. J.*, **31**, 2095 (1937).
[10] Taylor, T. G., *Biochem. J.*, **54**, 48 (1953).
[11] Schales, O., and Schales, S. S., *Arch. Biochem.*, **11**, 445 (1946).
[12] Friedman, T. E., and Haugen, G. E., *J. Biol. Chem.*, **147**, 415 (1942).
[13] Pucher, G. W., Abrahams, M. D., and Vickery, H. B., *J. Biol. Chem.*, **172**, 579 (1948).
[14] Eggleston, L. V., and Krebs, H. A., *Biochem. J.*, **45**, 578 (1949).
[15] Chain, E. B., Paladino, S., Ugolini, F., Callow, D. S., and Van der Sluis, J., *Rendiconti Ist. Sup. Sanità*, **17** (English translation in the press ; 1954).

## Decomposition of Oxalate by *Streptomyces*

The microbial degradation of oxalate is relatively a rare phenomenon. During the last decade, however, some valuable information on the isolation and study of some more oxalate-decomposing organisms, mostly bacteria, has been reported. The work of Bhat and Barker[1], Janota[2], Müller[3], Khambata and Bhat[4,5] and Jayasuriya[6,7] has contributed substantially in this direction. Nevertheless, there seems to be no published data available on the decomposition of



Two-day culture of a *Streptomyces* sp. (isolated from cellulose enrichment medium) growing on oxalate agar. Decomposition of oxalate is indicated by the clearing of calcium oxalate (halves) around the colonies. ⅔ nat. size

oxalate by *Streptomyces* and, so far as we are aware, this is the first report on this subject.

During the course of investigations on the micro-organisms associated with the intestine of the Indian earthworm[5], we encountered many *Streptomyces*. They were isolated from various enrichment media which were inoculated with suspensions of the intestinal contents of the worms. Details of the method of extracting the contents of the earthworm gut are obtainable elsewhere[4,5]. Three of these *Streptomyces* were isolated from oxalate enrichment media and exhibited oxalate-decomposing ability as evidenced by halo formation around the colonies when grown on a slightly modified Bhat and Barker's oxalate agar medium containing either yeast autolysate or yeast extract[4,5].

Stimulated by this interesting observation, we experimented further by streaking on oxalate agar twenty more *Streptomyces* isolated from the other enrichments also, namely, cellulose, asparagine and nitrogen-free enrichments. All, except one, displayed the characteristic clear-cut halo formation, strongly suggesting oxalate decomposition. The accompanying photograph strikingly illustrates the oxalate-decomposing ability of a *Streptomyces* species. Subsequent permanganate titrations carried out on eight-day old cultures of all the twenty-three *Streptomyces* grown in Bhat and Barker's liquid oxalate medium containing 0·1 per cent yeast extract confirmed our belief that oxalate was decomposed by these *Streptomyces*. Even the single isolate which did not exhibit halo formation on oxalate agar, on titration did show a negligible (0·2 per cent) decomposition of oxalate. The amount of oxalate decomposed by the other isolates varied from 6·3 per cent to as high as 83·4 per cent, but many decomposed more than 70 per cent of oxalate. It is, however, very necessary to emphasize the fact that our streptomycetes decomposed oxalate only in the presence of yeast extract. In oxalate media without yeast extract the *Streptomyces* gave scant or no growth. It may also be mentioned that three of these were identified as species closely related to *Streptomyces cellulosae*. The others could not be identified specifically but have been described in a doctoral dissertation submitted by one of us (S. R. K.)[6].

From these observations, it is felt that the oxalate-decomposing ability of *Streptomyces* is worth further exploration.

We are indebted to Mr. P. R. Gupta for taking the photograph.

S. R. Khambata*
J. V. Bhat*

Microbiology Department,
St. Xavier's College,
Bombay.
August 1.

* Present address: Indian Institute of Science, Bangalore, India.

[1] Bhat, J. V., and Barker, H. A., *J. Bact.*, **55**, 359 (1948).
[2] Janota, L., *Med. Doświadczalna i Mikrobiol.*, **2**, 131 (1950).
[3] Müller, H., *Arch. Mikrobiol.*, **15**, 137 (1950).
[4] Khambata, S. R., and Bhat, J. V., *J. Bact.*, **66**, 505 (1953).
[5] Khambata, S. R., and Bhat, J. V., *Proc. Indian Acad. Sci.*, Sect. B, **38**, 157 (1953).
[6] Jayasuriya, G. C. N., *J. Gen. Microbiol.* (*Proceedings*), **10**, vi (1954).
[7] Jayasuriya, G. C. N., *Biochem. J.* (*Proc. Biochem. Soc.*), **56**, xli (1954).
[8] Khambata, S. R., Ph.D. thesis, University of Bombay (1954).

## Invasiveness of Sarcoma Cells

It has recently been shown[1] that chick-heart fibroblasts in tissue culture influence each other's movement through their mutual contacts. In particular, it appears that when two fibroblasts touch, their further movement in the direction of their point of contact tends to be stopped. This phenomenon, which we called 'contact inhibition', is in principle capable of explaining many features of the behaviour of fibroblasts both in tissue culture and in the organism. Among other things, it implies a relative immobility within a group of fibroblasts, provided the group is enclosed by an external barrier of some sort, since the cells inhibit each other. Contact inhibition would therefore be expected to play a part in keeping the fibroblasts within an organism largely immobilized under normal conditions.

We have recently obtained evidence that contact inhibition occurs not only between fibroblasts from the same source, but between those coming from different organs and even from different species. A variety of cells are probably capable of immobilizing each other. The immobilization of cells within an organism breaks down, however, in the case of a malignant tumour. This suggests that sarcoma cells should be tested for contact inhibition against normal fibroblasts in tissue culture. The invasion of normal tissues by cancerous ones has previously been demonstrated to occur *in vitro*[2-4]. The observation that such invasion has occurred does not, however, necessarily mean that contact-inhibition has been absent. More direct tests are necessary.

We have made such tests, explanting two fragments of tissue close together in a liquid medium, and observing the two outgrowths of cells as they move towards each other on the solid surface and meet in the space between the explants. If contact inhibition operates between the cells of two such explants, there occurs a fundamental change of behaviour when junction between the two outgrowths is established: if they cannot turn aside, the cells almost stop moving. The result is that the space between the explants is filled by a continuous sheet of cells substantially one cell thick. This is what happens when the two explants are of neonatal mouse skeletal muscle, heart, bone or liver. When, however, one of the explants is from a mouse sarcoma (*S*37 or Crocker, kindly supplied by the Chester Beatty Research Institute) and the other from one of these neonatal organs, the result is strikingly different. We

have not been able to detect any change of behaviour in the sarcoma cells when they meet the fibroblasts. Both advancing outgrowths of cells continue moving after they have met, and become superimposed. We conclude that contact inhibition must be very slight or absent between these sarcoma cells and normal fibroblasts.

It would obviously be premature to assert that all malignant cells are characterized by reduction or absence of contact inhibition. A very large range of sarcomata and carcinomata, as well as of benign tumours and normal tissues, needs to be tested. Nevertheless, the hypothesis seems to be sufficiently plausible, in relating the invasiveness of malignant cells to a property of normal cells, to be perhaps worth following up by those who have access to a large range of tumours.

This work was made possible by a grant from the Nuffield Foundation, to which we wish to express our gratitude.

M. Abercrombie
Joan E. M. Heaysman

Department of Anatomy and Embryology,
University College,
Gower Street,
London, W.C.1.
Aug. 10.

[1] Abercrombie, M., and Heaysman, J. E. M., *Exp. Cell. Res.*, **5**, 111 (1953); **6**, 293 (1954).
[2] Carrel, A., and Ebeling, A. H., *J. Exp. Med.*, **48**, 105 (1928).
[3] Fischer, A., "Gewebezüchtung" (Müller and Steinicke, München, 1930).
[4] Earle, W. R., *Arch. exp. Zellforsch.*, **20**, 140 (1937).

## Intracellular Distribution of Histamine

Although histamine is widely distributed in the tissues, very little has been reported on its intracellular distribution. Recently, Copenhaver *et al.*[1] and Hagen[2], studying the histamine content of different cell fractions of dog liver, verified that the major amount of this substance was present in the mitochondrial fraction.

However, dog liver is exceptionally rich in mast cells[3], and the contamination of the mitochondrial fraction with mast cell granules during the differential centrifugation must be considered in the interpretation of these papers. We report here experiments performed in order to observe the distribution of mast cell granules in the different fractions of dog liver homogenate.

Samples of dog liver were obtained under pentobarbital anæsthesia and fractionated in 0·25 *M* sucrose as described by Schneider[4]. The nuclear, mitochondrial and microsome plus supernatant fractions were studied. Smears were made from these three fractions, fixed in 1 per cent lead sub-acetate in 50 per cent alcohol, stained with acidified Ehrlich's thionin and observed by normal and phase-contrast microscopy. Microscopic observation showed that the mitochondrial fraction was highly contaminated with mast cell granules which appeared as very small round metachromatic particles.

Many recent observations support the striking positive correlation between mast cell content of a tissue and its concentration of histamine[5]. Furthermore, the alterations of mast cells in conditions in which liberation of histamine occurs, both *in vivo* and *in vitro*[6], suggest that tissue histamine is present mainly in mast cells. By differential centrifugation of rat subcutaneous tissue a relatively pure fraction of mast cell granules could be obtained, and it was verified that the major amount of histamine was present in these granules, from which it could be released by heating in an acid medium or by the action of compound 48/80, a very potent histamine releaser. It is therefore probable that the higher histamine concentration of the mitochondrial fraction of dog liver might be due, at least in part, to its contamination with mast cell granules. A reconsideration of this problem seems to be necessary.

I. Mota
W. T. Beraldo
A. G. Ferri
L. C. U. Junqueira

Laboratory for Cell Physiology and
Department of Physiology,
Faculty of Medicine,
Department of Pathology,
Faculty of Veterinary Medicine,
University of São Paulo.
June 4.

[1] Copenhaver, J. H., Nagler, M. E., and Goth, A., *J. Pharm. Exp. Therapy*, **109**, 401 (1953).
[2] Hagen, P., *Brit. J. Pharmacol. Chemotherapy*, **9**, 100 (1954).
[3] Michels, N. A., in Downey, H., "Handbook of Hematology", 1 (Paul Hoeber, Inc., New York, 1938).
[4] Schneider, W. C., in "Manometric Techniques and Tissue Metabolism" (Burgess Publishing Co., 1951).
[5] Riley, J. F., and West, G. B., *J. Physiol.*, **120**, 528 (1953). Riley, J. F., *Science*, **118**, 332 (1953).
[6] Wilander, O., *Skand. Arch. Physiol.*, **81**, Supp. xv (1939). Jaques, L. S., and Waters, E. T., *J. Physiol.*, **99**, 454 (1941). Mota, I., thesis, University of São Paulo (1953). Riley, J. F., *J. Path. Bact.*, **65**, 471 (1953). Mota, I., Beraldo, W. T., and Junqueira, L. C. U., *Proc. Soc. Exp. Biol. Med.*, **83**, 455 (1953). Benditt, E. P., Bader, S., Arase, M., Corley, C., and Lam, K. B., *Fed. Proc.*, **13**, 422 (1954).

## Destruction of Tumour Cells by Rift Valley Fever Virus

In the course of work on the effects of infection with several viruses upon different kinds of tissue cells from several animal species *in vitro*, it was found unexpectedly that Rift Valley fever virus has a marked destructive action upon rat sarcoma cells grown in tissue culture. A number of papers have appeared on the effects of infection with viruses upon various tumours in several animal species[1]. A destructive effect of the viruses of eastern equine encephalomyelitis and poliomyelitis on the tumour cells grown in tissue culture has been demonstrated by Bang and Gey[2] and by Scherer, Syverton and Gey[3] respectively; but no report of an effect of infection with Rift Valley fever virus upon tumour cells either *in vivo* or *in vitro* came to our attention. It is felt, therefore, that the results so far obtained by us are sufficiently interesting to merit publication at this stage.

Rhodamine *B* rat sarcoma[4] and fructose mouse sarcoma[5] were used for tissue culture experiments. The roller tube technique was used and the cover-slip technique in Porter flasks was employed for staining cells grown in tissue culture. Suitable pieces of tumour tissues were grown directly on the glass wall of the roller tube without clot or upon the cover-slip in a Porter flask with or without plasma clot. Nutrient medium (1·0 ml. per tube) consisted of 45 per cent Hanks's solution, 45 per cent horse serum (or human ascitic fluid) and 10 per cent swine (or chick) embryo extract (1 : 1 in Hanks's solution). 100 μgm. of

Table 1. CYTOPATHOGENIC EFFECT OF THE PANTROPIC STRAIN OF RIFT VALLEY FEVER VIRUS IN ROLLER TUBE CULTURES OF RAT SARCOMA CELLS

| No. of tube | Dilution of inoculum (0·1 ml. per tube) | Extent of sarcoma cell degeneration* (days after inoculation) | | | | | | | | | | | Effect of inoculum in mice† |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| 1 | $10^{-2}$ | − | + | ++ | +++ | | | | | | | | |
| 2 | " | − | + | ++ | +++ | | | | | | | | |
| 3 | $10^{-3}$ | − | + | ++ | +++ | | | | | | | | |
| 4 | " | − | + | ++ | +++ | | | | | | | | |
| 5 | $10^{-4}$ | − | − | ++ | +++ | | | | | | | | |
| 6 | " | − | − | ++ | +++ | +++ | | | | | | | |
| 7 | $10^{-5}$ | − | − | − | +++ | +++ | | | | | | | |
| 8 | " | − | − | − | +++ | +++ | | | | | | | 4/4 |
| 9 | $10^{-6}$ | − | − | − | +++ | +++ | | | | | | | |
| 10 | " | − | − | − | +++ | +++ | | | | | | | 4/4 |
| 11 | $10^{-7}$ | − | − | − | − | +++ | +++ | | | | | | |
| 12 | " | − | − | − | − | +++ | +++ | | | | | | 4/4 |
| 13 | $10^{-8}$ | − | − | − | − | − | − | ++ | +++ | +++ | +++ | | |
| 14 | " | − | − | − | − | − | − | − | − | − | − | − | 2/4 |
| 15 | $10^{-9}$ | − | − | − | − | − | − | − | − | − | − | − | |
| 16 | " | − | − | − | − | − | − | − | − | − | − | − | 0/4 |
| 17 | No virus | − | − | − | − | − | − | − | − | − | − | − | |
| 18 | " " | − | − | − | − | − | − | − | − | − | − | − | |

* Extent of cell degeneration: −, none; +, slight; ++, marked; +++, complete.
† Mice inoculated subcutaneously with 0·1 ml. of the inoculum. Numerator = mice that died; denominator = mice inoculated.

streptomycin and 100 units of penicillin per ml. were added to the medium. Cultures were re-fed at intervals of three to five days. After the cells had grown for a few days, 0·1 ml. of a dilution of virus suspension was added, and the condition of the cultures was followed for more than ten days.

The virus of Rift Valley fever was obtained through the courtesy of Prof. T. Nagano, of the Institute for Infectious Diseases, Tokyo. The pantropic strain of the virus was originally isolated in East Africa by Daubney, Hudson and Garnham[6], and Endo[7] succeeded in producing the neurotropic strain by serial passages of the pantropic strain in Maitland tissue culture with embryonic mouse brain. The strain is essentially similar in its properties to that produced by previous investigators[8]. The strains of the virus were used in the form of suspensions of infected mouse liver and mouse brain respectively.

The results of one experiment with the pantropic strain of the virus are presented in Table 1. It was observed that the more concentrated viral inocula destroyed the rat sarcoma cells grown in tissue culture within two to three days, whereas cultures inoculated with higher dilutions of virus showed destruction only after four to six days (see Fig. 1). Considerable multiplication of the virus was confirmed by subcutaneous mouse titrations of the supernatant fluids of cultures inoculated with smaller viral inocula. The titre of virus in the culture fluids rose rapidly to a maximum of $10^{-6}$ to $10^{-7}$ in a few days before the appearance of marked cell degeneration.

Similar results were obtained with the neurotropic strain of the virus, and comparable results were also obtained in the tissue cultures of fructose mouse sarcoma with both strains of the virus. Destruction of these tumour cell cultures with both strains of the virus could be completely prevented by pretreatment of the virus with immune rabbit serum prepared against the pantropic strain of the virus. The destructive effect of the virus upon tumour cell cultures is comparable to that of the virus of eastern equine encephalomyelitis upon one culture of a malignant-cell line of rat cells (*T*·333) reported by Bang and Gey[9].

It may be noted here that both strains have also marked destructive effect upon normal tissue cells, namely, embryonic human, rat, mouse and swine fibroblasts. Since none of several neurotropic viruses so far tested for destructive effect upon the rat and mouse sarcoma cells grown in tissue culture showed an effect comparable to that of both strains of the Rift Valley fever virus, it seems probable that the marked cytopathogenic effect is an inherent property of this virus which is not dependent on its neurotropism.

The finding that Rift Valley fever virus multiplied readily in tumour cell cultures with destruction of tumour cells led to a preliminary study demonstrating a marked oncolytic action of the neurotropic strain of the virus, which is non-lethal for mice when inoculated either subcutaneously or intraperitoneally, on the Ehrlich ascites tumour. When the mixture of a dilution of the virus and the undiluted ascitic fluid, previously incubated at 37° C. for 1 hr., was injected subcutaneously into mice, the growth of subcutaneous tumour was completely inhibited, even when the higher dilutions of the virus were used.

In another experiment, 0·2 ml. of 1 : 10 dilution of the neurotropic virus ($LD_{50}10^{-7\cdot6}$) was inoculated intraperitoneally into mice, injected four days previously with 0·2 ml. of undiluted ascitic fluid.

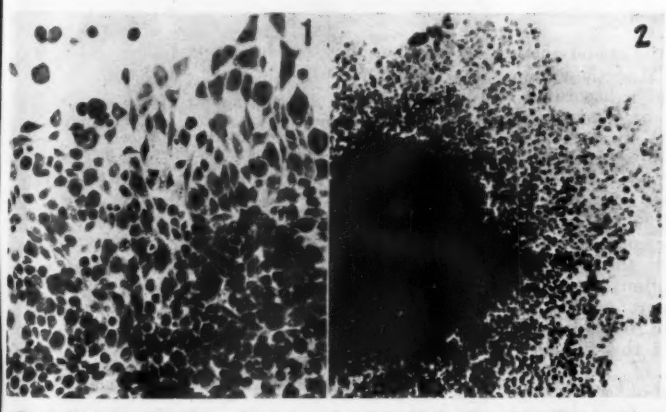



Fig. 1. Cytopathogenic effect of the pantropic strain of Rift Valley fever virus on rat sarcoma cells in tissue culture. Giemsa stain (approximately × 80). (1) Uninfected control culture shows thin spread of active healthy tumour cells on the seventh day. (2) Culture of the same tumour cells, destroyed by the virus, four days after inoculation

Marked destruction of tumour cells was observed, and in a few days no ascitic fluid could be obtained from mice infected with the virus. All the mice thus treated survived thirty days of observation, while the control ones died from ascites tumour. Mice receiving higher dilutions ($10^{-2}$, $10^{-3}$, $10^{-4}$) of the virus did not survive, although the amount of ascitic fluid was less than that of the control mice. The intracerebral mouse titrations of the supernatants of ascitic fluids showed that considerable multiplication of virus occurred. The oncolytic action was completely neutralized by pretreatment of the 1 : 10 dilution of the virus with immune serum. Koprowska and Koprowski[9] have already reported on a similar powerful inhibitory effect of Bunyamwera virus upon the Ehrlich ascites tumour.

Details of these and further experiments will appear elsewhere.

N. Takemori
M. Nakano
M. Hemmi
H. Ikeda
S. Yanagida
M. Kitaoka

National Institute of Health,
Minatoku, Tokyo.
June 1.

[1] Moore, A. E., *Ann. N.Y. Acad. Sci.*, **54**, 945 (1952).
[2] Bang, F. B., and Gey, G. O., *Bull. Johns Hopkins Hosp.*, **91**, 427 (1952).
[3] Scherer, W. F., Syverton, J. T., and Gey, G. O., *J. Exp. Med.*, **97**, 695 (1953).
[4] Umeda, M., *Gann*, **43**, 120 (1952).
[5] Takizawa, M., *Gann*, **34**, 1 (1940).
[6] Daubney, R., Hudson, J. R., and Garnham, P. C., *J. Path. and Bact.*, **34**, 545 (1951).
[7] Endo, M., *Virus*, **1**, 42 (1951).
[8] Mackenzie, R. D., and Findlay, G. M., *Lancet*, i, 140 (1936). Mackenzie, R. D., Findlay, G. M., and Stern, R. O., *Brit. J. Exp. Path.*, **17**, 352 (1936).
[9] Koprowska, I., and Koprowski, H., *Cancer Res.*, **13**, 651 (1953).

## Glycogen Secretion in the Epididymis

Very little information is available on the function of the epididymis and especially of the nature of its secretion products. During a study of the histochemistry of this organ in domestic and laboratory animals pictures were obtained which indicated the presence of glycogen in the epididymal secretion products.

Small pieces from various parts of the epididymis were fixed in Carnoy's fluid or in Serra's[1] acetic acid–formol alcohol and embedded in paraffin according to routine methods. Sections were cut at 5 microns, attached dry to slides, deparaffinized in benzene, coated with a very thin film of 'Celloidine' and treated with periodic acid and Schiff's reagent. Control sections without 'Celloidine' coating were immersed in a buffered solution of malt diastase at 37° C. for one hour and then treated as above. Other controls were placed in the buffer solution only before the staining procedure. As chemical fixation often produces diffusion of glycogen with subsequent unreliable localization of the reaction product the freeze-drying technique was used in order to avoid this possible source of artefacts. The apparatus of Glick and Malmström[2] as modified by Moberger *et al.*[3] was used. Paraffin sections were cut at 5 microns, fixed dry to the slides, deparaffinized, dried in the air, and then immersed in a 0·2 per cent solution of 'Celloidine' in

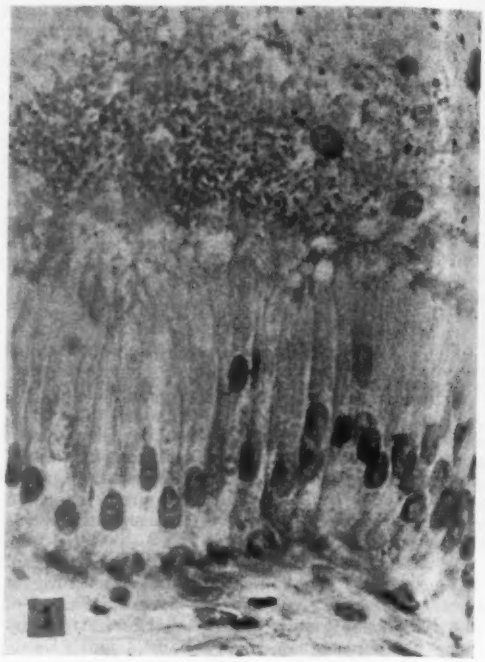


Fig. 1. Epithelium from the *corpus epididymidis* of rabbit. Large amounts of glycogen granules in the secretion. Fixation in Serra's fluid

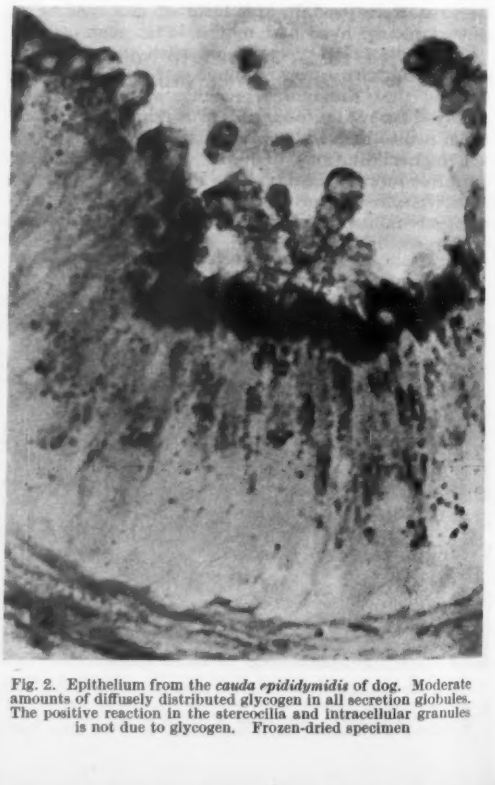


Fig. 2. Epithelium from the *cauda epididymidis* of dog. Moderate amounts of diffusely distributed glycogen in all secretion globules. The positive reaction in the stereocilia and intracellular granules is not due to glycogen. Frozen-dried specimen

ether and absolute alcohol. After drying in the air, the sections were treated with periodic acid and Schiff's reagent. Controls were prepared as described above.

Glycogen was demonstrated by both methods in the epididymal epithelium of several species, though in different amounts and different regions of the organ. In some regions moderate amounts were present in the secretion products. In globules lying free in the lumen, the glycogen was often less prominent or absent, especially in those intermingled with the spermatozoa. In frozen-dried material the reaction was diffusely distributed within the secretion globules, and stronger in their periphery. After chemical fixation small, heavily coloured granules were seen.

In the control sections a faint red colour persisted, and the stereocilia were generally still dark red.

McLeod[4] has shown that glycolysis and motility of human spermatozoa are produced by glycogen as well as by glucose and fructose under anaerobic conditions. The glycogen secretion reported here may therefore represent a mode of 'nutrition' of epididymal spermatozoa during the long time required for their passage through the organ.

A detailed description of the pictures observed in the different species will be published elsewhere.

LENNART NICANDER

Department of Anatomy and Histology,
Veterinärhögskolan,
Stockholm.
Aug. 10.

[1] Serra, J. A., *Stain Technol.*, **21**, 5 (1946).
[2] Glick, D., and Malmström, B. G., *Exp. Cell. Res.*, **3**, 125 (1952).
[3] Moberger, G., Lindström, B., and Andersson, L., *Exp. Cell. Res.*, **6**, 228 (1954).
[4] McLeod, J., *Amer. J. Physiol.*, **132**, 193 (1941).

## Use of *p*-Chloromercuribenzoic Acid in the Determination of Ascorbic Acid in the Presence of Sulphydryl Compounds

IN certain circumstances hydrogen sulphide, cysteine and related sulphydryl compounds react with 2 : 6-dichlorophenol-indophenol (indophenol) and thus may interfere with the determination of ascorbic acid using this reagent. In view of the known ability of *p*-chloromercuribenzoic acid to combine with sulphydryl compounds[1], the possibility of using this reagent to suppress such interference has been examined.

Results indicate that this reagent does not itself react with indophenol nor does it affect the determination of ascorbic acid in pure solution, using a colorimetric procedure based on the decolorization of excess indophenol. Under similar conditions the addition of *p*-chloromercuribenzoic acid has been found to suppress completely the decolorization of indophenol by hydrogen sulphide, cysteine and glutathione respectively.

The reagent has been used in the following manner : 1 ml. of *p*-chloromercuribenzoic acid solution (200 mgm./100 ml. in 0·05 *N* sodium hydroxide) was added to 3 ml. of standard ascorbic acid solution (0·0–2·0 mgm./100 ml.), or test solution, in 1·8 per cent (w/v) metaphosphoric acid solution. Because of the low solubility of *p*-chloromercuribenzoic acid at this *p*H (about 1·5) most of the excess reagent was precipitated. The solution containing the precipitate was allowed to stand for 5 min. and then centrifuged. To 2 ml. of the supernatant fluid was added 0·5 ml. sodium citrate solution followed by 1 ml. indophenol solution (4 mgm./100 ml.) and the optical density of the resulting colour determined 30 sec. after the addition of the dye using a Unicam spectrophotometer *S.P.* 600 at a wave-length of 520 mμ. The concentration of the sodium citrate used was such as to bring the final *p*H to 3·5. With solutions of ascorbic acid in 1·8 per cent (w/v) metaphosphoric acid a concentration of 7 per cent (w/v) was required.

It is suggested that *p*-chloromercuribenzoic acid may be of value in increasing the specificity of the indophenol reaction applied to the determination of ascorbic acid in biological material containing sulphydryl compounds. It offers advantages over mercuric acetate[2] for the removal of cysteine and certain other sulphydryl compounds in that subsequent treatment with hydrogen sulphide, to remove the excess mercuric ions and to convert the dehydroascorbic acid formed to ascorbic acid, is not required. It thus avoids a procedure which itself introduces several sources of error[3,4] and does not permit the determination of ascorbic acid in the presence of dehydroascorbic acid.

The effect of *p*-chloromercuribenzoic acid on the determination of the 'ascorbic acid' content of human plasma is being studied and it is hoped to publish results shortly.

We are indebted to Dr. A. B. Roy for the gift of the *p*-chloromercuribenzoic acid and for suggestions which led to its use described here.

J. A. OWEN
B. IGGO
D. B. HORN

Department of Clinical Chemistry,
University, Edinburgh.
Aug. 9.

[1] Hellerman, L., Chinard, F. P., and Ramsdell, P. A., *J. Amer. Chem. Soc.*, **63**, 2551 (1941).
[2] Emmerie, A., *Biochem. J.*, **28**, 268 (1934).
[3] King, C. G., *Physiol. Rev.*, **16**, 278 (1936).
[4] Roe, J. H., in "Methods of Biochemical Analysis", **1** (edit. by D. Glick ; Interscience Publishers, Inc., N.Y., 1954).

## A New Mixed Disulphide: Penicillamine–Cysteine

As part of a study of skin sensitization to penicillin and its derivatives, we have been investigating the behaviour of penicillamine (β,β′-dimethylcysteine). Since D-penicillamine proved capable of eliciting allergic skin responses[1], it was expected that it would react with epidermal proteins[2], possibly through cystine or cysteine residues. Accordingly, it was of interest to determine whether this sulphydryl compound reacts with cystine or cysteine. It was found that a reaction occurs readily with cystine with the formation of a mixed disulphide which is here designated penicillamine–cysteine.

A typical experiment consisted of mixing 1 mgm. of D-penicillamine and 2 mgm. of L-cystine in 0·4 ml. of 0·5 *M* ammonium chloride at *p*H 7·4. Aliquots were analysed by ascending chromatography on paper with phenol–water as solvent. A new ninhydrin-positive compound was found, $R_F = 0{\cdot}41$, about midway between cystine, $R_F = 0{\cdot}2$, and penicillamine, $R_F = 0{\cdot}7$. The new compound gave a positive nitroprusside reaction only after reduction with alkaline cyanide solution. It yielded cysteic acid and penicillamine sulphonic acid after oxidation with

aqueous bromine. Reduction of the compound with sodium sulphite solution at *p*H 7 yielded two distinct spots on paper: the more rapidly moving spot was indistinguishable from penicillamine and the slower ($R_F = 0{\cdot}1$) had the same $R_F$ as material prepared by sulphite reduction of cystine[3]. Oxidation of these reduction products with bromine water yielded penicillamine sulphonic acid and cysteic acid respectively.

The mixed disulphide was prepared on a larger scale in the following way: 200 mgm. of D-penicillamine and 400 mgm. of L-cystine were mixed in 8 ml. of water which was adjusted to *p*H 9 with 5 *N* ammonium hydroxide. (Some of the D-penicillamine used was kindly furnished by Bristol Laboratories, Syracuse, N.Y., and by Charles Pfizer and Co., Brooklyn, N.Y.) The mixture was shaken intermittently at room temperature for eight days. The soluble fraction was evaporated to dryness, then dissolved in 2 ml. of 2 *N* hydrochloric acid and run on a 70 × 1·2 cm. 'Dowex 50' column in the hydrogen ion form (200–400 mesh, 8 per cent cross-linking). The chromatogram was developed with 2·5 *N* hydrochloric acid at a rate of flow of 5 ml. per hour. The fractions containing the mixed disulphide (430–545 ml.) were combined and evaporated to dryness *in vacuo* at 40°. The residue was dissolved in 1·5 ml. of 30 per cent ethanol–water (v/v). This solution was neutralized with 2 *N* ammonium hydroxide, and long, colourless, needle-like crystals formed immediately. After standing overnight at 4° the crystalline product was washed in the cold with water, 30 per cent ethanol–water and absolute ethanol. Yield: 50 mgm., m.p. 195° (dec.). Elemental analysis (Schwarzkopf Microanalytical Laboratory, Woodside 77, N.Y.). Calc. for $C_8H_{16}N_2S_2O_4$: C, 35·8; H, 6·00; N, 10·4; S, 23·9. Found: C, 35·8; H, 5·48; N, 10·1; S, 23·3. The compound is hygroscopic and the elemental analysis has been corrected for a water content of 8 per cent.

A rapid formation of the mixed disulphide of D-penicillamine and glutathione was also observed when penicillamine and oxidized glutathione reacted in *M* ammonium chloride solution at *p*H 7·4.

Studies on the reaction of penicillamine with various proteins are now in progress.

The support of this work by grants from the Standard Oil Company (New Jersey), New York City, and the National Microbiological Institute of the National Institutes of Health, United States Public Health Service, is gratefully acknowledged. We wish to thank Dr. Norton Nelson for his helpful interest in this study.

Milton Tabachnick
Herman N. Eisen
Bernard Levine

Institute of Industrial Medicine,
New York University
Post-Graduate Medical School,
New York 16.
Aug. 3.

[1] Eisen, H. N., Levine, B., and Tabachnick, M. (unpublished data).
[2] Eisen, H. N., and Belman, S., *J. Exp. Med.*, **98**, 533 (1953).
[3] Clark, H. T., *J. Biol. Chem.*, **97**, 233 (1932).

## A New Glass Cell for Preparative Counter-Current Distribution

We make a distinction between preparative and the usual counter-current distribution. By the latter we mean, of course, the very efficient method of separation based on extraction, devised chiefly by L. C. Craig[1]. With this method only a single addition of mixture to the apparatus is possible. This fact, although the amount added can sometimes be fairly large, limits the preparative value of the method. Several columns, working on a continuous basis (repeated or continuous addition of the mixture being possible) have been designed. These columns, however, lack the advantages of counter-current distribution where each cell is completely separated from the others. The principal advantages in this connexion are the easy mathematical interpretation and the possibility of stopping the operation at any time.

By preparative counter-current distribution we mean a technique based on separate cells and allowing repeated additions of the mixture to be separated. Such a technique has been described by Verzele[2]. The method differs essentially from the usual counter-current distribution in two ways: (*a*) the repeated additions must be made somewhere in the middle of the extraction train; this presents no difficulty; (*b*) the lower phase must be transferred also, and in a direction opposite to the displacement of the upper phase.

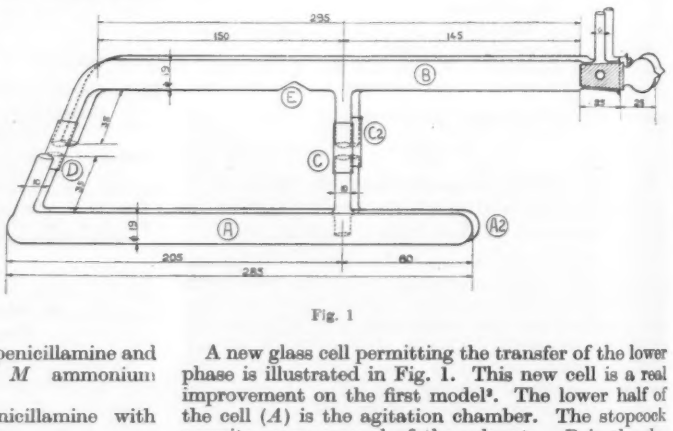



Fig. 1

A new glass cell permitting the transfer of the lower phase is illustrated in Fig. 1. This new cell is a real improvement on the first model[2]. The lower half of the cell (*A*) is the agitation chamber. The stopcock permits easy removal of the solvents. *B* is the decantation chamber. *E* prevents the solvents flowing in the wrong direction. The cells can be joined together with plastic tubing or fused on to one another, depending on the ultimate use of the apparatus. Plastic tubing can sometimes be a nuisance when concentrations are determined spectrophotometrically.

*Transfer of the upper phase.* (1) Turn the cell 90° in a clockwise direction. The upper phase flows from *A* through *C* into the decantation chamber *B*. (2) Turn the cell farther in the clockwise direction to 200° from the original state. The lower phase of *A*2, withheld in *A*2 by the extension of *C*2, flows through *D* into the decantation chamber *B*. The lower phase of *A* flows into the preceding decantation chamber, not shown on Fig. 1. (3) Turn farther clockwise to make a full turn (360° from the original position). The two phases flow together through *D* into the

agitation chamber *A*2. Whereas the lower phase returns to the agitation chamber from which it came, the upper phase has been transferred from *A* to *A*2. Although the operation has been described stepwise, it is clear that a transfer of the upper phase is obtained by one uninterrupted full turn in the clockwise direction.

*Transfer of the lower phase.* Steps (1) and (2) of the upper-phase transfer remain unchanged. (3) The horizontal agitation state is attained by turning anti-clockwise for 200°. The two phases flow together through *C* into the agitation chamber *A*. The upper phase returns whence it came; the lower phase has been transferred into a direction opposite to the direction of transfer of the upper phase (from *A*2 to *A*).

Transfer of the lower phase is obtained by turning 200° in a clockwise direction and back again.

It is obvious that the usual counter-current distribution can also be carried out with this cell.

A train of 216 such cells has been constructed in this laboratory.

M. Verzele*
F. Alderweireldt

Laboratory for Organic Chemistry,
University of Ghent.

* Associate of the F.N.R.S.

[1] Craig, L. C., Hausmann, W., Ahrens, E. A., and Harfenist, E., *Anal. Chem.*, **23**, 1236 (1951).
[2] Verzele, M., *Bull. Soc. Chim. Belg.*, **62**, 619 (1953).

## Hydrogen Reduction of Tungsten Oxides

Previous work[1] has shown that hydrogen reduction of tungsten trioxide gave the β-oxide ($W_{20}O_{58}$)[2], which was then apparently reduced both to β-tungsten ($a = 5{\cdot}04$ A.) and to tungsten dioxide or the γ-oxide.

Further work has been done on the reduction of the trioxide, dioxide and γ-oxide. The latter had the composition $W_{18}O_{49\cdot2}$, compared with the stoichiometric composition $W_{18}O_{49}$[3]. 25 mgm. and 50 mgm. samples and a hydrogen flow-rate of 600 c.c./min. were used instead of the 500 mgm. samples and 100 c.c./min. used previously. Reaction products were identified by X-ray diffraction analysis.

The first stage in the reduction of tungsten trioxide was always the formation of β-oxide. The final product was pure β-tungsten at 465°–584° C., but at 645° C. it consisted of α-tungsten and a small amount of the β-form. Samples partially reduced at 465°–645° C. contained only β-oxide and tungsten metal, but the dioxide also was formed at 677° C. and by reduction in moist hydrogen at 645° C.

The final products of reduction of γ-oxide at 470°–584° C. were α- and β-tungsten mixtures, the α-tungsten content increasing with increasing temperature. At 658° C. no β-tungsten was in the final product; but it was present in partially reduced samples. In two samples partially reduced at 470° C. and 540° C. β-tungsten was found unaccompanied by α-tungsten.

The sole product of reduction of the dioxide at 547°–587° C. was α-tungsten.

The following conclusions are reached from this and previous work. The primary product of reduction of tungsten trioxide is β-oxide. β-Oxide is reduced directly to β-tungsten, γ-oxide to both α- and β-tungsten, and the dioxide to α-tungsten. β-Tungsten is formed from the β- and γ-oxides even at temperatures where it is rapidly converted to α-tungsten. Formation of the γ-oxide and dioxide during reduction of tungsten trioxide is not, as was hitherto thought, a necessary stage in the reaction, but is due to insufficiently rapid removal of water vapour from the reaction zone. The γ-oxide and dioxide may be formed by oxidation of the β-tungsten, or by growth of γ-oxide and dioxide nuclei, formed by oxidation of the primary β-tungsten nuclei.

Only the dioxide was completely reduced to metal. The sigmoid time-course curves for the trioxide flattened out at compositions in the range $WO_{2\cdot3-2\cdot4}$ and at about $WO_{2\cdot08}$ for the γ-oxide. Thus, removal of the oxygen was not quite complete in those cases where β-tungsten was formed. This supports the suggestion of Hägg and Schönberg[4] that β-tungsten is a metallic oxide, with a maximum oxygen content corresponding to the composition $W_2O$.

I wish to thank Mr. M. G. Harwood, who was responsible for the X-ray crystallography, and Dr. J. A. M. van Moll and the Directors of Philips Electrical, Ltd., for permission to publish these results.

M. G. Charlton

Material Research Laboratory,
Philips Electrical, Limited,
New Road,
Mitcham Junction, Surrey.
Aug. 16.

[1] Charlton, M. G., *Nature*, **169**, 109 (1952).
[2] Magnéli, A., *Ark. Kem.*, **1**, 513 (1950).
[3] Magnéli, A., *Ark. Kem.*, **1**, 223 (1949).
[4] Hägg, G., and Schönberg, N., *Acta Cryst.*, **7**, 351 (1954).

## Quantitative Infra-Red Analysis of Mixtures

Differential analysis of mixtures is an accepted technique in ultra-violet spectrophotometry[1], and it is the purpose of this communication to describe the successful application of this technique to infra-red solution analysis, where a double-beam instrument is used. Double-beam infra-red spectrophotometers enable complex mixtures of isomeric or closely related substances to be analysed; but it is usually necessary to detect a major peak peculiar to a particular component of the mixture. This is not always possible, and minor peaks, or peaks where interference is present, have been used. In the latter case corrections are applied for the interfering substance, which is separately estimated. Interference can also affect the shoulders adjacent to an analytical peak, so, while the actual peak is unaffected, the resultant extinction coefficient is questionable, because the true base line ($I_0$ value) is in doubt.

This interference was eliminated by adding to the compensating cell (usually containing solvent only) the interfering substance in a concentration equivalent to that present in the mixture, and dissolved in the solvent used in the sample cell. Alternatively, a different substance having an absorption peak at the same frequency may be used. The resulting trace shows the absorption of the mixture, less that of the interfering substance. Solvent absorption is eliminated by having low concentrations (which may involve thick cells) and using either matched cells or a variable-space cell of thickness similar to that of a fixed-thickness cell. This technique has been used for measuring the percentage of *trans* unsaturated

fatty acids (expressed as elaidic acid) in the presence of *cis* unsaturated fatty acids and saturated fatty acids. Such an analysis is complicated by the fact that the *trans* double-bond peak at 965 *K** lies on the side of a major carboxyl peak at 933 *K*. It is therefore masked by this peak; but when a solution of mixed $C_{18}$ fatty acids in carbon disulphide in the sample cell is measured against a similar concentration of stearic acid in carbon disulphide in a compensating cell of the same thickness, the carboxyl peak can be completely compensated and the resultant graph is that due to the *trans* double-bond alone. By this method 0·5 per cent *trans* unsaturated acids in the presence of *cis* unsaturated acids and saturated acids was accurately determined. Similarly, a mixture of DDT *pp'* and *op'* isomers and BHC γ-isomer was analysed by first compensating for total DDT at 1,015 *K* and measuring γ-isomer BHC at 686 *K* and 910 *K*, and secondly compensating for γ-isomer BHC at 910 *K* and measuring total DDT at 1,015 *K* and *pp'* to *op'* ratio at 806 *K*.

The method is also recommended as a criterion of purity. Similar weights of pure compound and sample are separately dissolved in equal volumes of an appropriate solvent and placed in matched sample cells. If the pure compound and sample are identical, the resultant trace is a line at 100 per cent transmittance and any impurity is readily detected.

Compensation by the above techniques may lead to low-energy transmission by each beam, and precautions may be needed to maintain instrument performance under the conditions of low energy and low signal-to-noise ratio. Such precautions include increasing energy from source, increasing slit widths, increasing electronic gain, and reducing consequent noise by the use of appropriate filters and slow scanning speeds.

I. R. C. McDonald

Dominion Laboratory,
Department of Scientific and Industrial Research,
Wellington, New Zealand.

* Following the recommendation of the Joint Commission of Spectroscopy, the symbol *K* is used for denoting the unit of wave number previously designated as cm.$^{-1}$.

[1] Beroza, M., *Anal. Chem.*, **25**, 112 (1953).

## A New Circuit for balancing the Characteristics of Pairs of Valves

In circuits containing balanced valves, as used in such applications as push-pull output stages or in d.c. amplifiers, it is customary to balance the valves by means of external circuit adjustments so that errors caused by differences in their characteristics are reduced. There are various methods of doing this[1]; but none of these gives compensation for all characteristics simultaneously, as it is possible to make adjustments to only one of the three properties, namely, zero balance (equality of static plate currents), stage gain and effect of changes of cathode-supply voltage.

Two valves of the same type rarely have identical characteristics, the variations being greater than can be accounted for by variations in electrode geometry. This is due to the well-known variations in the emission characteristics of the oxide cathode.

At a given operating point, differences in the characteristics of two valves caused by variation of the work function can be compensated by an appropriate adjustment of the cathode temperature and hence of the heater supply voltage.

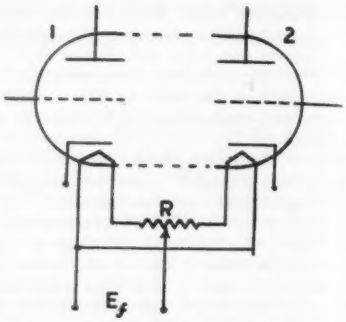



Fig. 1. A new circuit for balancing both static and dynamic properties of a pair of triodes by adjustment of the heater voltages

This approach leads to the very simple circuit of Fig. 1 for the balancing of a pair of triodes (or pentodes at fixed screen voltage). A small difference in the heater supply voltages is introduced by the potentiometer *R*, of a few ohms resistance, in series with the heater supply circuit. A suitable method of balancing is to adjust *R* until the static plate currents are equal. Experimental measurements on a number of valves of different types have shown that, when this is done, the other parameters of the valves are also brought into balance. That is, the mutual conductances of the two valves are almost equal (to within 2 per cent), and the compensation for heater supply voltage changes is also balanced. This result would presumably apply only to valves in which the differences in geometry are negligible.

It is found experimentally that it is necessary to provide for a difference of 10 per cent in the heater supply voltages, and that approximately 50 per cent of valves of the same type can be balanced with differences of only 5 per cent. In many cases (that is, d.c. amplifiers) it is desirable to operate the heaters at a reduced voltage, and the voltage drop in *R* is then unimportant.

Full experimental details will be published elsewhere.

R. E. Aitchison

Electrical Engineering Department,
University of Sydney,
Sydney, N.S.W.
June 22.

[1] Verhagen, C. M., *Proc. Inst. Rad. Eng.*, **41**, 616 (1953).

## Cytological Polymorphism in the Nematode *Haemonchus contortus* (Rudolphi 1803) Cobb 1898

Recent observations by Roberts, Turner and McKevett[1] have indicated that the so-called ovine and bovine 'strains' of *Haemonchus contortus* (Rud. 1803) are distinct species. This conclusion is based mainly on differences in the morphology of the infective larvæ and in the type of cuticular vulval process dominant in adult females in natural populations in each host. Supporting evidence was also found in heritability tests involving these differences. The measurements of the infective larvæ presented

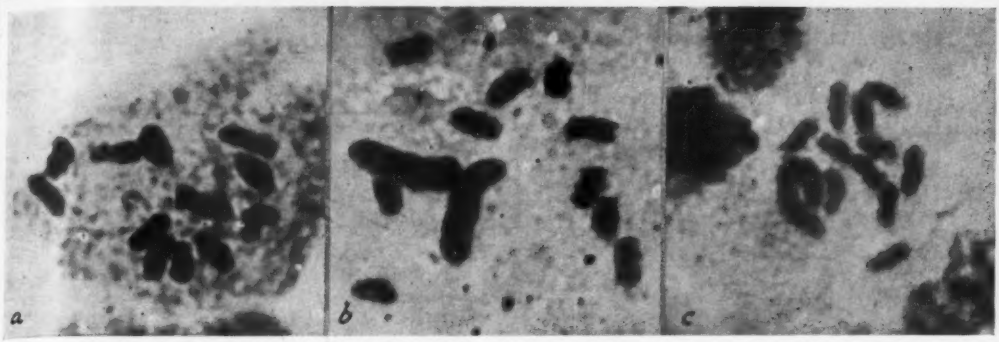



Fig. 1. Oogonial metaphase chromosomes of (*a*) *H. contortus* from a sheep; (*b*) *H. contortus* from a calf; (*c*) a hybrid *H. contortus*

by these authors, however, show some overlapping, and their heritability observations were carried only to the $F_1$ generation. For these reasons a cytological examination was undertaken and studies of the chromosomes were made on aceto-orcein squashes of the gonads.

In natural infestations the chromosome number for both forms is $2n = 11$ (♂), 12 (♀). Whereas gonial metaphase chromosomes of the worms from sheep are all of similar size (Fig. 1,*a*), those of the worms from cattle include one very large chromosome in the male and two in the female which are almost three times as long and twice as thick as any of the ten equal-sized autosomes (Fig. 1,*b*). These very large chromosomes are undoubtedly sex chromosomes, their increased size being due to the presence of heterochromatin, since they exhibit positive heteropycnosis along their complete length during prophase of gonial mitosis.

Examination of a pure infestation of cattle origin established in a worm-free calf showed the possession of large sex chromosomes to be a constant attribute of the form infesting cattle. It was also demonstrated that the presence of the large chromosomes does not influence in any way the type of vulval process in the female. A similar finding in respect of the chromosome picture was also obtained in naturally occurring infestations in sheep.

In an experiment designed to ascertain whether interbreeding occurs between the two forms, the large sex chromosomes were used as 'markers' and a worm-free sheep was given equal numbers of infective larvæ from cattle and from sheep. Infective larvæ from this lamb constituted the $F_1$ generation and were fed to a second worm-free lamb, which was slaughtered when the worms had reached maturity. Seventy-seven female worms from the second lamb were examined cytologically; of these, fifty possessed sheep-type chromosome complements, twenty-four the cattle type and three displayed a hybrid make-up, in which only one outsize chromosome was present (Fig. 1,*c*). The eggs from each of the seventy-seven females were cultured and those from all females, including the three hybrids, developed and hatched normally.

Another factor of interest was the finding of a triploid female among the parent generation in which the eighteen metaphase chromosomes were of equal length.

Although this experiment demonstrated the existence of a low percentage of a fertile hybrid form in an artificial population, it is highly significant that, to date, no hybrids have been found in examinations of natural populations.

Further work will be carried out on natural populations in which it is known that interbreeding has had every opportunity to occur over a number of years. The results of these observations will assist in deciding the question of specific distinctness.

Details of this work will be published elsewhere.

K. C. Bremner

Division of Animal Health and Production,
Commonwealth Scientific and
Industrial Research Organization,
Veterinary Parasitology Laboratory,
Yeerongpilly, Queensland.
May 24.

[1] Roberts, F. H. S., Turner, H. N., and McKevett, M., *Aust. J. Zool.* (in the press).

## Photoperiodic Control of Germination in Seed of Birch (*Betula pubescens* Ehrh.)

It is well known that the flowering response of both short-day and long-day herbaceous species is governed by the day-length conditions to which the mature leaves are exposed, and that the meristematic tissue of the shoot apex is insensitive. It has been shown for certain woody species, however, that direct photoperiodic perception may occur in the meristematic tissue of both dormant resting-buds and actively growing apices, in relation to dormancy phenomena. Thus, the unchilled resting-buds of dormant leafless seedlings of *Fagus sylvatica* and *Betula pubescens*[1,2] may be induced to expand by exposure to long-day conditions. Similarly, actively growing, leafy seedlings of *Betula pubescens* may be induced to form resting-buds by direct exposure of the apical region of the shoot to short-day conditions, regardless of the conditions of day-length under which the mature leaves are maintained. It is of interest, therefore, to investigate whether the embryos of such woody species also show photoperiodic effects in relation to dormancy, and experiments have been carried out with seeds of birch for this purpose.

Preliminary tests showed that the *unstratified* (that is, unchilled) seeds will not germinate on moist filter paper in complete darkness at room temperature but will do so if exposed to light, and hence are light-requiring seeds. Experiments were carried out to determine the effect on germination of exposing the

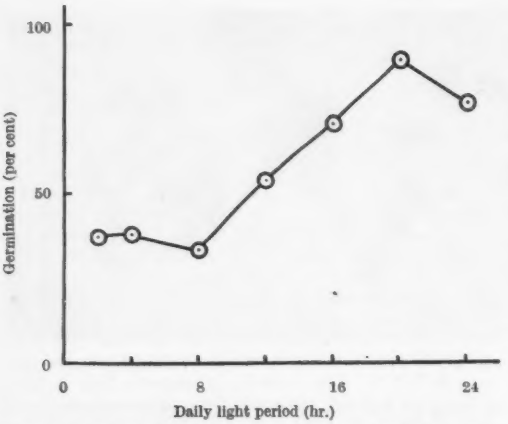



Fig. 1. Effect of day-length upon germination of unchilled birch seed. (Illumination with red light at 1,000 ergs/cm.²/sec. Temperature during both light and dark periods, 15° C.)

seeds to various lengths of photoperiod. For this purpose red light (falling within the range 5800–7000 A.) derived from red fluorescent tubes in conjunction with red 'Perspex' (*R*.400) was used, the intensity at the level of the seeds being approximately 1,000 ergs/cm.²/sec. It was found that the germination is markedly affected by the conditions of day-length, but that this photoperiodic response is profoundly modified by the prevailing temperature conditions.

Fig. 1 illustrates the effect of varying lengths of photoperiod, within 24-hr. cycles, at 15° C. The number of germinated seeds in each treatment was counted daily and the treatments continued until there was no further increase in germination, that is, for 12–14 days. (A considerable proportion of the seeds were found to lack embryos and these were excluded from the germination percentage.) It is seen that a high percentage germination is obtained with photoperiods of 16 hr. or longer, but under short-day conditions the maximum germination is only of the order of 30 per cent. A number of further experiments have been carried out which confirm that this is a true photoperiodic effect and that the final germination percentage is not governed by the total quantity of light received. For example, the percentage germination following exposure to seven cycles consisting of 8 hr. light/8 hr. dark was 60 per cent compared with 30 per cent following the same number of cycles consisting of 8 hr. light/16 hr. dark, although the total period of illumination (56 hr.) was the same for both treatments.

With higher temperature conditions (20°, 25° C.) the final germination was 93 per cent under both 8-hr. and 20-hr. photoperiods (with 24-hr. cycle) and the photoperiodic nature of the response is thus not apparent. At these higher temperatures even a single light-exposure followed by storage in the dark resulted in considerable germination (Table 1), whereas at 15° C., with corresponding periods of illumination, only a very low percentage germination was obtained.

Table 1. Effect of Single Light-exposure on Percentage Germination at 20° C.

| Duration of light period (hr.) | 0 | 0·25 | 1·0 | 4·0 | 8·0 | 20·0 | 24·0 |
|---|---|---|---|---|---|---|---|
| Percentage germination | 0 | 37·5 | 42·3 | 47·2 | 54·0 | 66·6 | 68·9 |

The effect of a single 4-hr. period of illumination with red light at 20° C. may be nullified if followed by illumination for 30 min. with infra-red radiation (intensity 3,000 ergs/cm.²/sec.) within the range 7200–10,000 A., and in this respect the responses of birch seeds resemble those of lettuce seeds[3].

Seed which had been soaked and stored in the dark at 5° C. for six weeks was found to germinate rapidly in darkness on transfer to a temperature of 15° C. Chilled birch seed has apparently, therefore, no light requirement. There is thus a close parallel between the responses of both resting-buds and embryos of birch, for both structures show a requirement for long photoperiods to overcome dormancy when unchilled, but show no light-requirement after chilling[3].

These effects in birch provide direct evidence in support of the hypothesis, put forward by Borthwick[4] and his co-workers, that the same photo-reaction is involved in both light-sensitive seeds and in photoperiodic effects observed in the later stages of development.

M. Black
P. F. Wareing

Department of Botany,
University of Manchester.
Aug. 3.

[1] Wareing, P. F., *Physiol. Plant.*, **6**, 692 (1953).
[2] Wareing, P. F., *Physiol. Plant.*, **7**, 261 (1954).
[3] Borthwick, H. A., Hendricks, S. B., Parker, M. W., Toole, E. H., and Toole, V. K., *Proc. U.S. Nat. Acad. Sci.*, **38**, 662 (1952).
[4] Borthwick, H. A., Hendricks, S. B., and Parker, M. W., *Proc. U.S. Nat. Acad. Sci.*, **38**, 929 (1952).

## Magnetic Observations at Quetta during the Total Solar Eclipse of June 30

With the view of studying the effects of the total solar eclipse of June 30, 1954, on the magnetograms at Quetta, the Ruska magnetograph was set to run at 80 mm./hr., instead of the normal speed of 20 mm./hr. The Quetta Magnetic Observatory was approximately three miles south of the northern run of the shadow belt. The beginning of totality was 13h. 58·8m. G.M.T. and hence the corpuscular eclipse was to be expected at approximately 11h. 59m. G.M.T.

The day was magnetically almost quiet. The horizontal force curve (*H*-trace) is entirely smooth a few hours before and after the eclipse period. At 12h. 1·6m. G.M.T. (2·6 min. after the expected corpuscular eclipse time), a full oscillation of a period of 1·3 min. and an amplitude of 0·8 γ appears in the *H*-trace. The onset is towards the positive side. The trace remained slightly disturbed until 12h. 47m. G.M.T. At the same time a slight increase of declination (*D*) by 0·1′ (1·0 γ) also occurred.

At 13h. 57·2 m. a very minute onset towards the positive side of *H* occurred. The amplitude of the onset is approximately 0·4 γ and consists of a sequence of irregular oscillations which last for 0·8 min. only.

S. A. A. Kazmi

Pakistan Meteorological Department,
Magnetic Observatory,
Quetta.

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, October 11

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. L. L. Whyte: "One-way Processes in Physics and Biology" (Chairman's Address).

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Dr. G. M. Dyson: "The Economics of Research in the Fine Chemicals and Pharmaceutical Industries".

## Tuesday, October 12

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1), at 1 p.m.—Dr. Alastair Heron: "Scientific and Professional Problems for the Psychologist in Industry".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. W. L. Wilson: "The Design and Construction of the Handling and Treatment System for Liquid Radioactive Wastes"; Mr. R. H. Burns: "Operational Experiences with a Handling and Treatment System for Liquid Radioactive Wastes".

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. D. W. van Krevelen (Holland): "Heterogeneous Reaction Processes. 1: Gas-Liquid Reaction Processes".* (Further Lecture on October 22.)

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. I. Prigogine (University of Brussels): "Irreversible Processes". Lecture 1: "Thermodynamics of Irreversible Phenomena".* (Further Lectures on October 14 and 15.)

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of the Subject of Electro-magnetism".

SOCIETY FOR VISITING SCIENTISTS, LTD. (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion meeting on "Nuclear Energy in Industry and Medicine". Chairman—Prof. Sir Francis Simon, F.R.S. Speakers—Dr. J. V. Dunworth, Prof. J. Rotblat and Mr. F. H. S. Brown.

## Tuesday, October 12—Wednesday, October 13

IRON AND STEEL INSTITUTE (joint meeting with the NATIONAL FORGEMASTERS' ASSOCIATION and the CHAMBRE SYNDICALE DE LA GROSSE FORGE FRANCAISE, at 4 Grosvenor Gardens, London, S.W.1), at 9.45 a.m. daily—Discussion of Technical Papers.

## Wednesday, October 13

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. A. Neuberger, F.R.S.: "Porphyrin Metabolism".*

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. O. T. Jones, F.R.S.: "The Geological Evolution of Wales and the Adjoining Regions" (Tenth William Smith Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. C. W. Oatley: Chairman's Address.

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP—NUTRITION PANEL (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. Magnus Pyke: "Food, Chemistry and Nutrition".

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Department of Psychology, Birkbeck College, Malet Street, London, W.C.1), at 8.15 p.m.—Prof. C. A. Mace: "'Thinking' as a Psychological Function of Social Groups".

## Thursday, October 14

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, NORTHERN BRANCH of the PHILOSOPHY OF SCIENCE GROUP (at the University, Sheffield), at 5.30 p.m.—Annual General Meeting. At 7.30 p.m. (in conjunction with the SHEFFIELD UNIVERSITY EXTRA-MURAL DEPARTMENT)—Mr. L. L. Whyte: "The Growth and Implications of Modern Physics—a Philosophical View".

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Prof. R. J. Sarjant and Dr. D. Smith: "Heat Transfer in a Continuous Reheating Furnace"; Dr. N. P. Bacon and Prof. R. J. Sarjant: "The Significance of Sectional Heat Balances and Burner Performances in Furnaces".*

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. A. Morris Cassie: "The Operation of a High-Voltage D.C. System". (From a series of five lectures on "Electrical Power Transmission by High Voltage D.C.")*

SCIENTIFIC FILM ASSOCIATION, SCIENCES COMMITTEE (in the Theatre of the Shell Film Unit, Room 106, Shell-Mex House, Strand, London, W.C.2), at 6.30 p.m.—Meeting on "The Use of Film in Chemical Investigations".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

## Friday, October 15

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. W. R. Bailey, F.R.S.: Presidential Address.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Literary and Philosophical Society, Newcastle upon Tyne), at 6.15 p.m.—Opening General Meeting.

QUAKER SCIENTISTS' FELLOWSHIP (in the Small Meeting House, Friends House, Euston Road, London, N.W.1), at 6.30 p.m.—Sir Russell Brain: "Science and Religion".*

## Friday, October 15—Saturday, October 16

BIOCHEMICAL SOCIETY (at the National Institute of Medical Research, The Ridgeway, Mill Hill, London, N.W.7), at 2.30 p.m. on Friday and 11.30 a.m. on Saturday—Scientific Papers.

## Saturday, October 16

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—The Reverend A. M. Jones: "African Music" (illustrated by gramophone records).*

---

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER, Grade B (with a degree and some teaching experience) IN BIOLOGY—The Principal, North Staffordshire Technical College, Stoke-on-Trent (October 12).

HEAD (with experience of university scholarship work with sixth form) OF THE GEOGRAPHY DEPARTMENT—The Headmaster, Solihull School, Warwickshire (October 13).

ASSISTANT LECTURER (professionally qualified and with adequate industrial experience) IN ELECTRICAL ENGINEERING—The Principal, Dudley and Staffordshire Technical College, Dudley (October 14).

ASSISTANT LECTURER (with a degree in engineering and/or in agriculture, and practical experience of farm implements and machinery) IN AGRICULTURAL ENGINEERING—The Secretary, North of Scotland College of Agriculture, 41) Union Street, Aberdeen (October 14).

SENIOR SCIENTIFIC OFFICER (with a university degree of high standard in electrical engineering or physics, with mathematics or mathematical physics to final honours standard or equivalent qualifications) IN THE AERONAUTICAL RESEARCH LABORATORIES, Department of Supply, Fishermen's Bend, Victoria, Australia, to be responsible for the investigation of instrumentation schemes in the field of aeronautical research, and detailed investigation of resultant problems and the subsequent development of necessary apparatus—The Senior Representative (A.P.22), Department of Supply, Australia House, Strand, London, W.C.2 (October 14).

ASSISTANT LECTURER (Grade A) IN BIOLOGY—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (October 16).

LABORATORY TECHNICIAN (with experience in general laboratory practice, the construction of experimental physical apparatus and instrument repair, and preferably with a knowledge of glass blowing)—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (October 16).

PRINCIPAL (graduate in agriculture or appropriate sciences and with experience in teaching, practical farming and administration) OF THE CUMBERLAND AND WESTMORLAND FARM SCHOOL, Newton Rigg, near Penrith—The Director of Education, 5 Portland Square, Carlisle (October 16).

RESEARCH ASSISTANTS (2) AT THE CAVENDISH LABORATORY to help with the work in radio astronomy—The Secretary of the Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge (October 16).

GUIDE LECTURER (with a university honours degree, and experience in lecturing or teaching, and preferably with a knowledge of a foreign language) at the Victoria and Albert Museum, London—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 4380/54 (October 19).

ASSISTANT IN THE DEPARTMENT OF GEOGRAPHY—The Secretary, The University, Edinburgh (October 20).

SOIL CONSERVATION OFFICERS (graduates in agriculture or agricultural engineering) in the Federal Department of Conservation and Extension, Federation of Rhodesia and Nyasaland—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (October 20).

ASSISTANT (with a degree in physics, together with some research experience and an actual or prospective interest in archæology) IN THE ARCHÆOLOGICAL RESEARCH LABORATORY—The Registrar, University Registry, Oxford (October 23).

ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, The University, Hull (October 24).

LECTURER IN AGRICULTURAL ECONOMICS AND FARM MANAGEMENT at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 25).

SENIOR EXPERIMENTAL OFFICER (with a pass degree in mechanical engineering or chemical engineering or H.N.C. in either of these subjects, and experience in the design, manufacture, development, installation and operation of process and chemical plant incorporating modern heat and mass transfer principles, or of heat exchange equipment used in power stations) IN THE MECHANICAL ENGINEERING RESEARCH LABORATORY, Department of Scientific and Industrial Research, East Kilbride, near Glasgow, for duties which involve the design (or selection) and development of heat transfer equipment—The Secretary, Civil Service Commission, 30 Old Burlington Street, London, W.1, quoting S4382/54 (October 26).

LIBRARIAN, Grade 3 (Fellow or Associate of the Library Association or with the Diploma of the London University School of Librarianship, and considerable experience (preferably technical) of library work, and preferably with a degree in a science subject, and a knowledge of languages) in the Ministry of Agriculture and Fisheries Veterinary Laboratory, Weybridge, Surrey—The Civil Service Commission, Burlington Gardens, London, W.1, quoting 4379/54 (October 28).

LIBRARIAN (with experience in a scientific library)—The General Secretary, The Chemical Society, Burlington House, Piccadilly, London, W.1 (October 29).

RESEARCH ASSISTANT (with some research experience in a branch of applied mathematics or numerical analysis, and preferably with previous experience of automatic computing) IN THE COMPUTING MACHINE LABORATORY—The Registrar, The University, Manchester 13 (October 30).

SENIOR LECTURER IN ANTHROPOLOGY at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, October 30).

CHAIR OF APPLIED MATHEMATICS at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, October 31).

CHEMIST (graduate of a recognized university, and preferably with some postgraduate experience and training), with the Tobacco Research Board of Southern Rhodesia, for duties which cover the analysis of soils and tobacco leaf from experimental plots—The Director, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia (October 31).

LECTURER IN VETERINARY SURGERY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

SENIOR LECTURER and a LECTURER IN THE DEPARTMENT OF ZOOLOGY at the University of Natal, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, October 31).

SENIOR EXPERIMENTAL OFFICER (with a pass degree in an appropriate subject, or technical qualification, and preferably with experience in research work and electronics, and prepared to undertake and supervise development of electronic apparatus) IN THE CENTRIFUGE UNIT of the Royal Air Force Institute of Aviation Medicine, Farnborough, Hants, to work in a small scientific unit concerned with affects of acceleration on man and animals—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S4383/54 (November 9).

LECTURER (Grade I) IN CHEMICAL ENGINEERING at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 15).

SENIOR LECTURER or LECTURER IN PHILOSOPHY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, November 15).

DEPARTMENTAL ASSISTANT (preferably with a degree in dairying) IN DAIRYING, at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

ENGINEERS and PHYSICISTS (Experimental Officer and Assistant Experimental Officer grades, with at least H.S.C. (pass degree, H.N.C. or near equivalent an advantage)), in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.247/52A.

RESEARCH ASSISTANT IN THE PHYSICS DEPARTMENT, for problems concerned with the design of a high pressure Wilson Cloud Chamber—The Registrar, Imperial College, London, S.W.7.

RESEARCH ASSISTANT (man or woman) in the field of physical chemistry (reaction kinetics)—The Secretary, University College, Exeter.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemistry, and preferably with experience in thermochemistry, reaction kinetics and/or optical techniques), with the United Kingdom Atomic Energy Authority, Fort Halstead, Kent, for research on some of the physical and physico-chemical aspects of detonation and associated phenomena—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 235/WG/54.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

The Oxford System of Decimal Classification for Forestry. (Being the definitive English version as authorized by the Rome Congress of the International Union of Forest Research Organizations, Sept. 1953, and published on their behalf by the Commonwealth Agricultural Bureaux.) Pp. 115. (Farnham Royal: Commonwealth Agricultural Bureaux, 1954.) 10*s*. [207

Department of Agriculture for Scotland. Memoirs of the Soil Survey of Great Britain–Scotland. The Soils of the Country Round Banff, Huntly and Turriff (Lower Banffshire and North-West Aberdeenshire). By Dr. R. Glentworth. (Sheets 86 and 96.) Pp. x+169+24 plates. (Edinburgh: H.M. Stationery Office, 1954.) 17*s*. 6*d*. net. [207

Department of Scientific and Industrial Research. Report of the Building Research Board, with the Report of the Director of Building Research for the year 1953. Pp. vi+66+16 plates. (London: H.M. Stationery Office, 1954.) 3*s*. 6*d*. net. [207

Brown's Coppice: a Survey. By the Natural History Society of King Edward VI Grammar School, Camp Hill, Birmingham. Pp. vi+79+11 plates. (Camp Hill, Birmingham: Natural History Society of King Edward VI Grammar School, 1954.) 5*s*. [207

Ministry of Health; Department of Health for Scotland. Poliomyelitis—Medical Memorandum. Pp. 13. (London: Ministry of Health, 1954.) [207

Air Ministry: Meteorological Office. Meteorological Reports, No. 14: Sea-Breezes at North Front, Gibraltar. By A. Ward. Pp. ii+8+5 plates. (M.O. 535*l*.) (London: H.M. Stationery Office, 1954.) 1*s*. 6*d*. net. [207

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1954. No. 3: Some Recent Advances in Physical Chemistry. By Dr. A. R. J. P. Ubbelohde, F.R.S. Pp. ii+20. (London: Royal Institute of Chemistry, 1954.) [237

Is Management a Profession? By L. Urwick. Pp. 27. (London: Urwick, Orr and Partners, Ltd., 1954.) [237

Boundaries of Physics. By Prof. G. O. Jones. (An Inaugural Lecture delivered on 2nd March, 1954, Queen Mary College, University of London.) Pp. 22+2 plates. (London: Queen Mary College (University of London), 1954.) [237

Department of Scientific and Industrial Research. Forest Products Research. Bulletin No. 31: Prevention of Decay of Wood in Boats. By J. G. Savory. With a contribution on Electrochemical Attack by D. F. Packman. Pp. iv+18+8 plates. (London: H.M. Stationery Office, 1954.) 2*s*. net. [237

National Institute of Agricultural Botany. Thirty-Fourth Report and Accounts, 1953. Pp. 48. (Cambridge: National Institute of Agricultural Botany, 1954.) [237

## Other Countries

Smithsonian Institution: United States National Museum. Proceedings of the United States National Museum. Vol. 103, No. 3325: The Relationships of Old and New World Melanians. By J. P. E. Morrison. Pp. 357–394+plate 11. Vol. 103, No. 3326: Preliminary Analysis of the Fossil Vertebrates of the Canyon Ferry Reservoir Area. By Theodore E. White. Pp. 395–438. Vol. 103, No. 3327: A Review of the Labrid Fish Genus Wetmorella, with descriptions of New Forms from the Tropical Indo-Pacific. By Leonard P. Schultz and N. B. Marshall. Pp. 439–448+plate 12. Vol. 103, No. 3328: Review of the Atlantic Periwinkles, Nodilittorina, Echininus, and Tectarius. By R. Tucker Abbott. Pp. 449–464. Vol. 103, No. 3329: Mammals of Northern Columbia, Preliminary Report No. 7: (Genus *Tapirus*), with a systematic review of American Species. By Philip Hershkovitz. Pp. 465–496. Vol. 103, No. 3330: A Revision of the Goatfish Genus Upeneus, with descriptions of Two New Species. By Ernest A. Lachner. Pp. 497–532. (Washington, D.C.: Government Printing Office, 1954.) [207

Dendron. (News Bulletin of the International Dendrology Union.) Vol. 1, No. 1, July, 1954. Pp. 24. (Oisterwijk, Netherlands: J. Bergmans, International Dendrology Union, 1954.) [207

Notulæ Naturæ of the Academy of Natural Sciences of Philadelphia. No. 247 (June 5, 1953): New and Interesting Species of Foraminifera from the Vincentown Formation. Part 2: Forms Previously Described. By James D. McLean, Jr. Pp. 16 (4 plates). No. 248 (June 5, 1953): Notes on Peruvian Dendrocolaptidae, Conopophagidae and Rhinocryptidae. By James Bond. Pp. 7. No. 249 (July 20, 1953): A New Slender Cone from the Gulf of Mexico. By Thomas L. McGinty. Pp. 2. No. 250 (October 7, 1953): Three Undescribed North American Leeches (Hirudinea). By J. Percy Moore. Pp. 13 (1 plate). No. 251 (October 21, 1953): New Records of Symbiocladius Equitans (Claassen), with some notes on the Genus (Diptera: Tendipedidae). By Selwyn S. Roback. Pp. 2. No. 252 (October 21, 1953): Results of the Catherwood–Chaplin West Indies Expedition. Part 7: The Lichens. By William L. Dix. Pp. 3. No. 253 (October 21, 1953): Tendipedid Larvæ from the St. Lawrence River (Diptera: Tendipedidae). By Selwyn S. Roback. Pp. 4. (Philadelphia: Academy of Natural Sciences of Philadelphia, 1953.) [207

Notulæ Naturæ of the Academy of Natural Sciences of Philadelphia. No. 254 (November 24, 1953): Euphrasia in China (Scrophulariaceae). By Hui-Lin Li. Pp. 6. No. 255 (December 9, 1953): Notes on the Peruvian Icteridae, Vireonidae and Parulidae. By James Bond. Pp. 15. (Philadelphia: Academy of Natural Sciences of Philadelphia, 1953.) [207

Union of South Africa. Department of Commerce and Industries: Division of Fisheries. Investigational Report No. 15: The South African Pilchard (*Sardinops ocellata*), Development, Occurrence and Distribution of Eggs and Larvæ, 1950–51. By D. H. Davies. Pp. 26+6 plates. (Pretoria: Government Printer, 1954.) [207

Egypt. Ministry of Commerce and Industry. Department of Mines for Mines and Quarries: Mineral Research Section. Summary of Prospecting in Wadi El-Gemal Area, Eastern Desert, 1948 and 1951. By M. Sadek. Pp. vi+21+3 maps and 20 plates. (Cairo: Government Press, 1953.) [207

Publications de l'Institut National Turc de Bibliographie. Bibliographie des Articles Parus dans les Periodiques Turcs. 1952—Index des Noms d'Auteurs. Pp. 60. Bibliographie des Articles Paris dans les Periodiques Turcs. 1953, 1–3 (Janvier-Mars). Pp. 130. (Istanbul: Milli Egitim Basimevi, 1952 and 1953.) [207

Meddelande Från Lunds Astronomiska Observatorium. Ser. 1, Nr. 181: On the Eberhard Effect at Different Developers, with special regard to the influence of potassium bromide and sodium sulphite. By Nils Hansson. Pp. 393–410. Ser. 1, Nr. 184: Formulæ and Tables for the Numerical Computation of Mean Intensities and Fluxes in a Stellar Atmosphere. By Anders Reiz. Pp. 475–482. Ser. 1, Nr. 185: The Lunar Contours at the Total Solar Eclipse of 1954, June 30. By Henrik Kristenson. Pp. 411–416. Ser. 1, Nr. 186: On the Masses of Double Galaxies. By Erik Holmberg. Pp. 20. Ser. 2, Nr. 131: Historical Notes and Papers Nr. 23: Sur le Problème de l'Origine et de l'Evolution de l'Idée du Messie et de l'Eschatologie du Nouveau Testament. Par Knut Lundmark. Pp. 25. (Stockholm: Almqvist and Wiksells Boktryckeri, AB: London: H. K. Lewis and Co., Ltd., 1954 (Nos. 181, 184 and 185). Lund: Håkan Ohlssons Boktryckeri, 1954 (No. 186). Lund: C. W. K. Gleerup, 1954 (No. 131).) [207

United States Department of Commerce: National Bureau of Standards. National Bureau of Standards Circular 545: Subminiaturization Techniques for Low-Frequency Receivers. By Gustave Shapiro. Pp. iv+64. (Washington, D.C.: Government Printing Office, 1954.) 50 cents. [207